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Measuring tax administrations efficiency using data envelopment analysis: evidence from 26 European countries

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Abstract: The purpose of this paper is to assess the efficiency of tax administrations of 26 European countries, using data envelopment analysis. In particular, by applying the CCR data environment analysis (DEA) output-oriented model, the quantification of the tax administrations performance of 26 European countries is attempted in the areas of taxpayers' servicing, public revenue collection, strengthening voluntary tax compliance and targeted tax audits, the assessment of relative efficiency, the evaluation of results and the identification of fully efficient and inefficient tax administrations, in which a real improvement in their efficiency can be achieved. Subsequently, for the tax administrations that are assessed as inefficient, the reference units are identified, the missing quantity of outputs and the excess amount of inputs are estimated, in order to make them efficient and a set of possible ways of improving their operation is proposed, through specific changes.

Keywords: tax administration; efficiency; data envelopment analysis; DEA; tax compliance; tax audit; tax revenue.

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1 Introduction

The rational use of resources made available to the public sector and the need to implement high-level fiscal policies are considered to be crucial elements for economic growth and stability (Afonso et al., 2006). In recent years, various efforts have been made to measure the efficiency of public services through methods of quantitative analysis, including complex indicators and non-parametric approaches. In particular, Tanzi and Schuknecht (1997, 2000) used data from various socio-economic indicators in an effort to assess total public expenditure and to link it to the benefits of 18 industrialised countries. Subsequently, Afonso et al. (2006) improved this approach and defined complex indicators of measurement of public sector efficiency. In addition, Odeck (2005) analysed the usefulness of non-parametric methods to investigate the factors that increase productivity in the public sector. In this context, the improvement of the decision-making system relating to the tax collection process, requires the development of an objective and comprehensive assessment method, which can be applied consistently to all tax administrations (Gonzalez and Miles, 2000; Barros, 2007; Anastasiou et al., 2021a, 2020).

The basic tax compliance model as articulated by Becker (1968) and Allingham and Sandmo (1972), assumes that a reasonable taxpayer estimates the costs and benefits of avoiding taxes. If the expected benefits (less revenue 'lost' in taxes) outweigh the costs (probabilities of detection and penalties imposed), then the taxpayer will avoid paying the tax. According to this model, the increased risk of detection and penalties imposed increase the cost of tax evasion, which is expected to have a positive impact on taxpayers' compliance (Slemrod, 2007). Furthermore, the likelihood of detection is higher if the efficiency of the tax administration is high. Moreover, according to Escobari (2007), a more efficient tax administration leads to higher levels of tax compliance and lower tax evasion, which is achieved by intensifying tax controls and improving tax evasion disclosure skills. The efficiency of the tax administration is therefore an important factor in combating tax evasion and strengthening tax revenue.

In view of these, the effectiveness of the tax system, as the main source for funding the public expenditure, is a critical factor in fiscal policy, which is crucial to the development of any form of action by the public administration (Jiménez and Barrilao, 2001; Katharaki and Tsakas, 2010; Anastasiou et al., 2021b; Liargovas et al., 2019; Zervoyianni and Anastasiou, 2009; Anastasiou, 2009). Therefore, the success of a public revenue collection system, requires the development of methods of continuous monitoring and evaluation of the results of the tax administration (Faría and Yucelik, 1995). A first approach to the issue of measuring the efficiency of tax services at the international level, can provide evidence that tax authorities are indeed subject to scrutiny and continuous evaluation of their actions (Goode, 1981; Bird and de Jantsche, 1993; Bird et al., 2003). In the international literature there are significant research studies to measure the efficiency of tax administration of various countries (Moesen and Persoon, 2002; Gonzalez and Miles, 2000; Thirtle et al., 2000; Komninos et al., 2020; Barros, 2007; Dragojlovic et al., 2014; Jibril, 2020 and Nguyen et al., 2020), albeit to a limited extent, due to the policy of non-disclosure of data concerning public bodies and state entities, which has dominated the world in recent years (Barros, 2007).

Furthermore, even if tax administrations operate effectively, there are many factors which define their operating environment, which go beyond the scope of the administration of the tax services. In particular, factors such as the tax legislation, the tax

capacity of a country, the tax conscience of the citizens, the fiscal policy of the government, etc. although they significantly affect the efficiency of the tax administration, are largely outside the sphere of influence of her organs (Budryte, 2005). However, in the context of operation of the tax administration, the managers have the ability to influence a large extent various internal functions and procedures which are considered to be important for the efficiency of the organisation. Therefore, the tax administration must focus both on the relative efficiency of its services and on those factors which affect the efficiency of its action and on which they have some influence (Alm and Duncan, 2014).

In this regard, the main research questions of this study can be formulated as follows:

- a What is the degree of the efficiency of tax administrations in the areas of tax collection, the success of tax audits and the enhancement of the voluntary tax compliance?
- b What is the level of services provided by the tax administration?
- c What factors determine the relative efficiency of tax administrations?
- d What is the relative efficiency of tax administrations at European Union level and what are the conclusions of a comparative efficiency analysis?
- e What improvements can be made in terms of inputs and outputs so that inefficient tax administrations become effective?

In this context, the purpose of this study is to assess and compare the relative efficiency of tax administrations of 26 European countries, with regard to the collection of tax revenue, the effectiveness of tax audits, the level of services provided and the level of voluntary tax compliance. In particular, through the implementation of the data envelopment analysis (DEA), an attempt is made to quantify the efficiency of the tax services of the European countries under investigation, in the areas mentioned above, the assessment of the relative efficiency, the evaluation of the results, the identification of the fully efficient tax administrations and inefficient ones, in which a real improvement in their efficiency can be achieved. Subsequently, for the tax administrations which are considered inefficient, a set of possible ways to improve their operation is proposed, through specific changes, which can be applied as a measure of input saving, while estimating the magnitude of additional effect that the insufficient unit can achieve, without the need to use additional resources.

The main contribution of the research study is to develop a comprehensive approach to the assessment and measurement of the relative efficiency of the tax administration, at European level, in order to identify the strengths and weaknesses of each individual tax administration, to establish a homogeneous framework for assessing the level of operation of tax administrations, in such a way as to allow comparison and the formulation of a commonly accepted point of view between stakeholders, e.g., state authorities, international organisations, rating agencies, scientific institutions and organisational strategies, on the situation of the tax administration of a country, highlighting issues of lags in the objectives set, which can be addressed through tailored political and administrative measures, within the framework of a more general policy of convergence of the performance of tax administrations. These points, after all, are the difference between this research and other studies, which focus on assessing the relative efficiency of the tax services of a particular country or a group of countries, mainly in the

field of tax revenue collection, since it is the first attempt to develop a common framework for evaluating European Union's tax administrations, through a systematic analysis of the administrative dimension of performance in crucial areas of action by the tax authorities, providing an additional information tool for tax policy makers.

This paper is structured as follows: Section 2 reviews the relevant literature and analyses the empirical results of previous surveys on the efficiency of tax administrations, Section 3 presents the methodology to be used, Section 4 presents the data and describes the variables of the DEA models and Section 5 analyses the empirical results of the DEA and assesses the efficiency of tax administrations under investigation. In addition, useful elements are provided, to improve the efficiency of inefficient tax administrations, through specific changes in the level of inputs and outputs. Finally, Section 6 draws useful conclusions and proposes specific policies to improve the efficiency of tax administrations in an effort to converge at European Union level.

2 Literature review

Although the efficiency of tax authorities is one of the four 'rules' recommended by Smith (1776) in his treatise on taxation, the research on measuring the performance of tax administrations seems to be limited, as the focus is more on investigating the cost of tax compliance at the individual level than on measuring the effective operation of tax authorities (Sandford et al., 1989; Slemrod, 1992). Although the research work published on this subject is limited, it provides useful conclusions on the functioning of tax administrations and the ways of improving the performance of tax services.

Gonzalez and Miles (2000) attempted to analyse the efficiency of 15 regional tax offices in Spain in 1995 using the DEA method, by setting as an input the ratio of tax auditors to the total staff and outputs the ratio of the number of tax office's actions to the total number of taxpayers and the ratio of debt to gross value added. The results showed that the average efficiency of the tax services was 0.81 and only one of the tax administration offices examined was considered to be effective.

Moesen and Persoons (2002) analysed the relative efficiency of 289 Belgian tax offices in 1991, using the non-parametric methods free disposal hall (FDH) and DEA. In particular, the researchers used as input the labour and as output the number of tax returns audited, with varying degrees of complexity. The results of the survey highlighted the importance of organisational planning in enhancing the efficiency of tax administrations, especially at the level of the central tax administration (CTA). Equally important was the role of management skills, as it was found that services with qualified staff, with a high level of training, achieved better results. Therefore, the investment of the tax administration in human capital for the acquisition of skills is considered necessary.

In Barros (2007), using the DEA, tried to assess the technical and allocative efficiency of 41 tax offices in the Lisbon region between 1992 and 2002. In the analysis carried out, the number of taxpayers, the rents paid for the establishment of tax offices and the number of employees were used as inputs, whereas the amount of personal income tax (PIT), corporate income tax (CIT), the total value of VAT, inheritances, donations and other taxes, were received as outputs. The results of the survey showed that the CTA is unable to achieve the objectives set.

Katharaki and Tsakas (2010) studied the technical efficiency and scale efficiency of 27 tax agencies in Greece, in the period 2001–2006. The methodology used to calculate

the level of efficiency and the classification of tax services was the DEA, in which they were used as inputs, the number of employees in each tax office, the number of computers operating in each tax office and the number of natural and legal persons under the responsibility of each tax office. Respectively, were received as outputs, the tax payments made by natural persons and those by legal persons. Furthermore, a window analysis was conducted to identify efficiency and stability over time and a Tobit analysis to examine the role of non-discriminatory factors in the performance of each tax office. The results of the analysis showed that the 'scale size' and the structure of the regional economy in which tax offices operate, are important factors influencing their effectiveness.

Ryu and Lee (2013) investigated how the effectiveness of the collection of national tax by the Korean tax administration has changed in the period 1998–2011. Using DEA, they estimated the efficiency scores of six tax agencies for each of the 14 years of the period 1998 to 2011. In the analysis carried out, direct taxpayers, indirect taxpayers and real GDP were used as inputs and direct taxes and other taxes were used as outputs. The average of the overall performance scores was estimated at 0.62 for the aggregate sample of 84 observations, indicating that there was a significant level of resource waste in tax collection activity. In addition, the trend analysis showed that the aggregate efficiency of tax services declined steadily over time since the currency crisis of 1997.

In Alm and Duncan (2013), through their research, tried to measure the relative efficiency of 30 OECD countries by using DEA and econometric analysis, for the period 2005–2009. In their three-stage, input-oriented DEA model, they considered as inputs the salaries of employees and the operating costs of the information system of tax administration and as outputs the PIT, the CIT and the value added tax (VAT) as totals and sub-combinations thereof. The results of the survey showed that 12 of the 30 countries surveyed were relatively efficient in tax collection and at the same time it was found that with the current level of outputs, countries have a margin to reduce their use of inputs by 10% to 13%.

Fuentes (2014) studied the productivity evolution of the tax offices of the Alicante province of Spain between 2004 and 2006 using an output-oriented DEA based on the Malmquist Index. In order to calculate the productivity levels, he used as inputs the number of employees in the tax offices and the area where the tax office is located and as outputs the number of taxpayers and tax returns. The results of the survey showed that during the period 2004 to 2006 average productivity increased by 5,73%, with a clear improvement of all those elements that constitute the Malmquist productivity index.

In Dragojlovic et al. (2014), assessing the level of services provided to taxpayers, analysed the efficiency of 16 OECD countries in 2009 using the DEA (Input oriented, CRS) method. In the implementation of the DEA, the ratio of the wage costs to the total operating costs of the tax administration, the number of employees in tax audit procedures as a percentage of the total staff and the number of employees involved in forcing debt collection procedures as a percentage of the total employees were used as inputs and as outputs the cost of the information systems as a percentage of the total operating costs of the tax administration, the percentage of employees involved in serving taxpayers and the rates of income tax returns of natural, legal persons and VAT, submitted electronically. According to researchers, the input/output ratio used in the analysis will influence the level of services provided to taxpayers and this in turn will shape the degree of tax compliance. In particular, the increased costs in information and technology systems, the greater number of employees placed in the service of taxpayers

and the higher level of use of electronic methods of filing tax returns, will lead to an improvement in the level of services provided by the tax administration and thus to an increase in the level of voluntary tax compliance. At the same time, the use of electronic means to fulfil tax obligations will reduce the cost of tax compliance and increase the tax administrations ability for tax audits. Moreover, the results of the survey showed that the Serbian Tax Administration provides services of a lower level than the other tax administrations of the survey, suggesting a corresponding shortfall in the level of voluntary tax compliance. At the same time, was identified a need to invest in new information systems and increase the number of young workers in information and technology services by providing better remunerations. According to the researchers, improving the quality of services provided by the Serbian tax administration to taxpayers through new electronic services is the only way to improve its effectiveness.

Fuentes and Lillo-Banuls (2015) studied the productivity evolution of the SUMA tax offices in Spain between 2004 and 2006 using the Malmquist Index based on the DEA model. The results showed an increase in productivity due to the technology and rational management of resources, while it was found that there was no evidence to suggest that the population or the number of municipalities affects productivity. In addition, the productivity effect was divided into two different elements, efficiency and technological change, with the aim of clarifying the role played by managers and the level of technology in the final performance data.

Huang et al. (2017) explored the performance of individual departments and the efficiency of resource use in Taiwan tax services for 2013, using DEA, where the business flow of local tax offices was divided into two stages: tax collection and tax management. The results showed that the efficiency was significantly different for tax collection and tax management, while recording increased levels of inefficiency in tax collection and management of taxes and outputs.

Rubio et al. (2017) analysed the Spanish tax administration, assessing the relative effectiveness of each regional service through a two-stage, output oriented DEA. In the study, a total of 47 regional offices were analysed, taking into account three elements:

- 1 current expenditure on goods and services
- 2 the number of tax returns processed on the basis of the two main direct taxes
- 3 the number of staff.

In addition, tax revenue was considered as output. The analysis showed that the effective action of regional offices may have increased by 21.6% as a result of good management.

Jibril (2020) analysed the technical efficiency and scale efficiency of 14 small and medium-sized tax offices in the city of Addis Ababa for the year 2015/2016, using DEA. The study used the total number of taxpayers, office rental costs and the total number of employees as inputs and the direct and indirect taxes as outputs. The average technical efficiency scores under CRS and variables return to scale, showed that tax offices are able to collect their current level of revenue with about 40.7% and 9% fewer inputs, respectively. In fact, for many of the inefficient tax services, they have been shown to overuse inputs. The scale inefficiency was estimated at 36.1%, with 75% of the tax offices showing increasing return to scale. This suggests that the managers of the tax collection offices need to improve operational planning and management practices in an effective manner. This could be done by adopting the best practices of other tax offices and a combination of factors improving tax compliance, minimising the cost of renting

offices, adequate investment and further training of employers and the adoption of new technologies related to the modernisation of tax offices. The next step would then be to improve scale efficiency by increasing scale operations through internal development.

Nguyen et al. (2020) tried to measure the performance of tax administrations in 44 countries, using advanced estimators such as the stochastic non-parametric envelopment of data by Johnson and Kuosmanen (2011, 2012) and the conditional order-m approach (Daraio and Simar, 2005, 2007) for two periods between 2008–2011 and 2012–2015. The results showed that the tax offices in these countries could have increased tax revenues, on average, around 58.7% and 34.2% for the two periods, respectively. Also, the level of tax revenue per capita could have increased by \$7,737 and \$4,677 for the two periods respectively. In addition, both estimators showed that in the last period (2012–2015) the tax administrations have a higher level of efficiency compared to the previous period (2008–2011).

From the literature analysis it is observed that most of the studies (Gonzalez and Miles, 2000; Barros, 2007; Dragojlovic et al., 2014; Huang et al., 2017; Jibril, 2020) have used the conventional DEA models which have no statistical properties and consequently provide biased estimates of efficiency (Simar and Wilson, 2007; Khan and Shireen, 2020; Khan and Gulati, 2021) and use traditional variables as inputs and outputs of the system, which mainly refer to the level of wage costs, the number of employees, the level of revenue collection, ignoring complex administrative parameters such as the time to comply, the level of digitisation of tax processes, the cost of investing in information systems and the level of success of tax audits. Also, none of the studies deals with assessing the efficiency of tax administrations at the level of the European Union. The present study attempts to fill these gaps in the literature.

3 Methodology – the DEA

The DEA is a method of benchmarking efficiency, based on linear programming technique. In fact, DEA is suitable for evaluating almost every homogeneous set of units and is recognised as a decision making tool in analyses of multiple criteria of distinct alternatives. The DEA measures the efficiency of a homogeneous set of decision making units with multiple inputs and multiple outputs (Cooper et al., 2011). It was originally developed by Charnes et al. (1978), for the evaluation of non-profit organisations in the public sector and since then it has been shown that this method identifies ways to improve the services of organisations, which are not easily identifiable by other techniques (Sherman and Zhu, 2006).

The main advantage of the DEA is that it can easily integrate multiple inputs and outputs, of a different nature, for the calculation of technical efficiency, without requiring the definition of predetermined weighting factors for each input and output, as opposed to numerical indicators approaches. Also, is it not necessary to define a mathematical formula representing the production function, and inputs/outputs can have different units of measure without requiring a reciprocal correlation in advance (Cook and Zhu, 2005; Thanassoulis, 2001). On the basis of these assumptions, the DEA technique can identify the efficient and inefficient units, the areas in need of improvement and assess the causes of inefficiency while drawing conclusions about the location of the unit as a whole (Eliophotou-Menon, 2019). However, like any empirical technique, the DEA is based on

a series of assumptions to be recognised in the interpretation of its results. In particular, the main drawbacks of the method relate to:

- a the sensitivity of the results to the selection of inputs and outputs and the size of the sample (Berg, 2010)
- b the tendency to increase the efficient units located at the efficiency frontier, as the number of inputs and outputs increases (Berg, 2010)
- c the fact that it is a non-parametric method (Berg, 2010)
- d estimates relative efficiency rather than absolute, so that the efficient units actually perform moderately
- e does not take into account the external environment of each unit which has a different impact on the efficiency (Cooper et al., 2007).

In mathematical terms, when analysing a data set of n DMUs, each observation, DMU_j ($1, 2, 3, \dots, j_n$), uses m inputs x_{ij} ($1, 2, 3, \dots, im$) for production s outputs y_{rj} ($1, 2, \dots, rs$) and the efficiency frontier or best practice boundary as reported, is determined by these n observations. On the basis of these assumptions, the total productivity is determined by a process of linear integration of the input-output combinations observed for each DMU and an empirical boundary of best practice is established which is the point of comparison and assessment of the efficiency of each DMU. Then, the DMUs, which are comparatively more efficient and belong to the efficiency frontier, become 'benchmarks' for the other DMUs whose efficiency deficit is determined by the distance from the efficiency frontier. Thus, the level of efficiency of a productive activity indicates the deviation or not of the observed productive activity of a DMU from the activity of the best in the sample. If a DMU is characterised as 100% efficient this does not mean that it cannot increase its productive achievements or further reduce its inputs. On the contrary, it quite simply means that there is no empirical evidence within the given reference set under consideration to show that another unit of similar condition exceeds its efficiency. It is important to point out that the DEA is a relative comparison tool, in which the reference benchmark is internal to the analysis and therefore what is presented is an evaluation of relative efficiency, with all that implies on the extent of the results.

The DEA model introduced by Charnes et al. (1978) is known as the CCR model. It operates with a constants return to scale (CRS), which means that a change in the level of inputs leads to a change in the level of outputs with the same ratio. The efficiency score is between 0 and 1 and when the efficiency ratio is 1 the decision making unit is fully efficient, while if it is less than 1, then the unit is characterised as inefficient. Also, the DEA model has developed into two distinct approaches for measuring the efficiency of operations, depending on the purpose of the evaluation and the capabilities of each decision-making unit, as to the levels of its inputs and outputs. The first is called input-oriented, which aims to minimise inputs given the level of outputs and is appropriate when inputs are under the control of the unit. The second is called output-oriented and is appropriate when the unit largely controls the outputs, as it aims to maximise the outputs given the level of the inputs. Furthermore, the full efficiency could be analysed by using Slack based model (Tone and Tsutsui, 2009). In this paper, DEA is used for comparative analysis of tax administration efficiency in the selected countries. During the development of the DEA, the basic output-oriented CCR model was applied, allowing constant return to scale so that an increase or decrease in inputs will result in an

increase or decrease in outputs by the same ratio. The CCR model was chosen because it is more rigorous in assessment of efficiency than the variable return to scale (VRS) model (Banker et al., 1984). In addition, it allows better discrimination between efficient and inefficient units. Furthermore, the reason for choosing to apply an output-oriented DEA model, is because the aim of this study is not to save resources but to maximise outputs using the given resources of the tax authorities. The aim is also to provide information and standards to inefficient tax administrations in order to adopt strategies for better use of their resources. Thus the relative efficiency of tax administrations is calculated on the basis of their ability to increase outputs, given the existing levels of inputs.

According to the CCR model, we assume that there are n DMUs ($j = 1 \dots n$), each of which uses m inputs $x_{1j}, x_{2j} \dots x_{mj}$ and produces s outputs $y_{1j}, y_{2j} \dots y_{sj}$, through a production technology of a constant returns to scale and we want to assess their relative efficiency (Charnes et al., 1978). In other words, we assume that each unit (tax administration) consumes different amounts x_{ij} from input i and produces an amount y_{rj} from output r . In addition, $x_{ij} \geq 0$ and $y_{ij} \geq 0$ and each DMU has at least one positive input and output. Output-oriented constant returns to scale (CRS) DEA model for measuring the efficiency is based on maximising the output values while keeping the input values constant. In order to rate the performance of a particular DMU (tax administration), DEA forms a weighted average of all the observations. The average represents a ‘composite’ DMU. The weights are to be determined so that the composite DMU is located on the frontier. It will represent ‘best practice’. The actual DMU at hand is then compared with its ‘best practice’. Denote the weights to be attached to the DMU_j by λ_j . They are to be determined so that the weighted sums $\sum_j Y_{rj} \lambda_j, r = 1, \dots, s$ represent ‘best practice outputs’ and so that $\sum_j X_{ij} \lambda_j, i = 1 \dots m$ represent ‘best practice inputs’. The weights are non-negative, $\lambda_j \geq 0, j = 1, 2, \dots, n$. If it so happens that

$$\sum_j Y_{rj} \lambda_j \geq Y_{r0}, r = 1, \dots, s$$

$$X_{i0} - \sum_j X_{ij} \lambda_j \geq 0, i = 1, \dots, m$$

then we say that the tax administration currently rated is dominated or inefficient because there exists a composite DMU (best practice) that requires fewer inputs to produce the same or greater outputs. If no such weights exist, then we say that the DMU (tax administration) is un-dominated or efficient and that it is located on the efficiency frontier.

Efficiency and inefficiency may alternatively be stated using an ‘output’-oriented formulation instead. Let ϕ be a scalar expansion factor and write

$$\sum_j Y_{rj} \lambda_j \geq \phi Y_{r0}, r = 1, \dots, s \tag{1}$$

$$X_{i0} - \sum_j X_{ij} \lambda_j \geq 0, i = 1, \dots, m \tag{2}$$

$$\lambda_j \geq 0, \text{ all } j \text{ and } \phi \geq 1 \tag{3}$$

This new condition makes use of a multiplier ϕ that expands the outputs from $Y_{r0}, r = 1 \dots s$ to $\phi Y_{r0}, r = 1 \dots s$ in an equi-proportional manner. This time, we say that the tax administration currently rated is inefficient if there exists a composite tax administration (output-oriented best practice) such that (1–3) are satisfied with $\phi > 1$. If $\phi = 1$ for all

such composite tax administrations then the specific tax administration is efficient. The corresponding output-oriented formulation of the CCR model is:

$$\begin{aligned}
 & \text{Max } \varphi \\
 & \text{Subject to} \\
 & \sum_j Y_{rj} \lambda_j \geq \varphi Y_{r0}, r = 1, \dots, s \tag{4} \\
 & X_{i0} - \sum_j X_{ij} \lambda_j \geq 0, i = 1, \dots, m \tag{5} \\
 & \lambda_j \geq 0, \text{ all } j \text{ and } \varphi \geq 1
 \end{aligned}$$

Note that equation (1) is the same as equation (4) and equation (2) is the same as equation (5). If the results of the evaluation of the above model for a DMU_n (output-oriented) are $\varphi^* = 1$, $\lambda_n^* = 1$, $\lambda_j^* = 1 (j \neq n)$, then the DMU_n is on the efficient frontier. However, there may be room in the non-dominant solutions for an individual reduction in inputs or an increase in outputs (slacks). The additional quantity of inputs and missing quantity of outputs of one point j_0 from any other point (X_j, Y_j) , is defined by the vectors of differences $s^- = \varphi X^{j_0} - \lambda X^j$ and $s^+ = \lambda Y^j - Y^{j_0}$, $s^+ \in R_+^m, s^- \in R_+^s$, which for the optimum value φ^* take different values, including the maximum values s^{+*}, s^{-*} . Since the price $1-\varphi^*$ corresponds to the greatest possible proportion of reduction of inputs since φ^* corresponds to the minimum, the difference $\Delta X^{j_0} = (1-\varphi^*)X^{j_0} + s^{-*}$, corresponds to the quantity by which the inputs of tax administration have to be reduced in order for the inefficient point j_0 to become efficient. In addition, the corresponding amount of increase in the tax administration's outputs of the inefficient point j_0 in order to make it efficient corresponds to the size $\Delta Y^{j_0} = s^{+*}$. These differences projected on the efficiency frontier define the point $(X_d^{j_0}, Y_d^{j_0})$, which is the improvement target for the point j_0 (Tone and Tsutsui, 2009; Du et al., 2010). Furthermore, the points which meet the conditions:

- a $\varphi^* = 1$
- b $s^{+*} = 0, s^{-*} = 0$,

i.e., they achieve relative efficiency of 1 and zero values in the slacks, they are called fully efficient (CCR-efficient) in the sense that they are on the efficiency frontier with relative efficiency 1 and at the same time it is not possible to improve an input or output without deteriorating their performance in another, respectively. Unlike the above, the points that meet only the condition $\varphi^* = 1$, displaying $s^{+*} \neq 0, s^{-*} \neq 0$, are called weak efficient as they show relative efficiency 1 and some non-zero values in the slacks, indicating that there is room for improvement in inputs/outputs of tax administration to achieve maximum efficiency.

4 Data and variable description

The study is based on an assessment of the performance of the tax administrations of 26 European countries in 2017, through the implementation of the DEA. In particular, an attempt is being made to measure and compare the efficiency of the tax administrations

of the Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, the Netherlands, Portugal, Romania, the Slovak Republic, the Republic of Slovenia, Spain, Sweden and the UK. The selection of the first 25 countries was made on the basis of their accession to the European Union, with all that entails, in terms of public revenue collection procedures and the development of a common strategy of action at taxation level, while the UK has recently left it (01.01.2021), but it is important to participate in the survey, as the reference year was a member of the European Union. The remaining two countries of the European Union (Luxembourg and Poland) are not included in the survey due to lack of critical data and performance results.

Furthermore, crucial elements for the selection of the sample are the characteristics of the economy in which the respective tax administrations operate, based mainly on the degree of development and modernisation of an effective tax system, the diversification of their economic activities, which translates into different forms of taxable material and concluding in a commonly accepted and comparable way of acting by tax authorities both in terms of tax rules and tax enforcement procedures.

In the field of the European Union, there are substantial differences in the overall tax burden as tax regulations are an internal matter for the Member States. The EU tax strategy is based on the belief that there is no need for full integrated harmonisation of member states' tax systems, provided that EU rules are followed. In addition, any proposal for EU action in the field of taxation must be taken into account. The principles of subsidiarity and proportionality. The main priority is the removal of tax barriers and the cooperation of tax administrations in controlling and combating VAT fraud. However, serious problems are the avoidance of double taxation, the difficulties in claiming tax refunds and obtaining information. Actions are also taken in the field of combating tax evasion regarding the taxation of savings and the provision of mutual assistance between tax administrations. At the same time, measures are being promoted to enhance transparency and fair tax competition.

The study refers to the performance of the above tax administrations in 2017, which is the last year for which data are available. The data were collected from official public sources (Intra-European Organisation of Tax Administration (ISORA) (ISORA-IOTA, 2020), PwC, World Bank Group and Eurostat, 2018) and are considered sufficient to assess the dynamic evolution of the efficiency of tax authorities. Furthermore, the purpose of the analysis is to assess and compare the relative efficiency of tax administrations with regard to the level of services provided, the collection of tax revenue, the level of voluntary tax compliance and the effectiveness of tax audits.

In the following sections, the four areas for assessing the efficiency of tax administration are analysed, the variables that have been selected to participate in the DEA models are described and their participation in the models as inputs or outputs is justified, according to the literature.

4.1 Efficiency of tax administrations in serving of taxpayers

The level of tax compliance is based both on taxpayers' attitude towards voluntary tax compliance and on the compliance strategy which facilitates compliance and at the same time puts pressure on taxpayers when non-tax compliance behaviours is observed. Given that most citizens want to comply with tax obligations, the duty of the state is to make it easier for them to do so, creating an adequate compliance model. Such an effort

presupposes the taking of appropriate initiatives by the tax authorities to improve the provision of services to taxpayers. A key element of this effort is the ability to use electronic (online) services, which increases voluntary tax compliance and reduces the compliance costs of taxpayers. Thus, in recent years, many tax authorities have been trying to extend the range of their available electronic services and to increase the quality of services to taxpayers by creating special service units, increasing funding in information technology (IT) systems and hiring qualified staff (Dragojlovic et al., 2014).

To assess the efficiency of tax administrations in the field of taxpayer's service, the following input and output parameters have been selected in the DEA model:

Inputs

- 1 salary cost / total operating expenditure of the tax administration (%)
- 2 percentage of staff allocated to audit, investigation and other verification
- 3 percentage of staff in enforced debt collections and related functions.

Outputs

- 1 cost of investment in IT systems (IT cost) / total operating expenditure of the tax administration (%)
- 2 Use of electronic filing: CIT, rate of tax returns e-filing CIT (%)
- 3 Use of electronic filing: PIT, rate of tax returns e-filing PIT (%)
- 4 Use of electronic filing: VAT, rate of tax returns e-filing VAT (%)
- 5 percentage of staff allocated to taxpayers' service and IT systems.

The above-mentioned input and output relationship chosen for the DEA, focuses on the analysis of the factors that influence and shape the level of services provided by the tax authorities, in such a way that the higher level of expenditure on IT systems, the higher percentage of staff available for the service of taxpayers and IT systems and the higher level of use of electronic methods of filing tax returns, is expected to lead to a higher level of services to taxpayers.

Regarding the distribution of the staff of the tax administration, the allocation of human resources in individual tasks (e.g., tax audit, forced collection of revenue, taxpayers' service, IT tasks, etc.) shall be deemed to be carried out on the basis of the degree of automation of the operating procedures of tax administrations, the level of external cooperation with private or other bodies, in particular in the field of information systems, the size of the tax administration services network and the rules for the allocation of staff, where they exist.

Furthermore, the use of electronic methods for submitting all kinds of tax returns is one of the most important elements of encouraging tax compliance as it reduces the level of compliance costs for taxpayers, increases the tax administration's ability for tax audit and leads to a higher level of tax compliance. The electronic services now available to tax authorities take various forms, such as the electronic filing of tax returns, the electronic payment of tax liabilities, the automated access to the taxpayers' bank account data, the electronic interconnection of cadastral offices with tax office records, the electronic information of third parties regarding the tax data of customers, suppliers, etc. Consequently, the operation of tax services under a regime of increased digitisation of

procedures will lead to a higher level of tax collection, a lower level of tax evasion and increased efficiency of tax administrations (Dragojlovic et al., 2014).

For these reasons it was considered necessary to introduce into the DEA model, the variables that represent the level of use of electronic methods of filling tax returns, by category of tax (CIT, PIT and VAT) and the degree of investment of the tax administration in information systems, as an approach to the quality of services provided and encouragement of tax compliance, by reducing the compliance costs of taxpayers. Furthermore, the variables related to the staff allocation in tax audit procedures, enforced debt collection and taxpayers service, were introduced into the model, on the one hand because the labour is a key factor of production in terms of available human resources (Katharaki and Tsakas, 2010) and on the other hand as an indicator of the degree of specialisation of the staff and the level of quality of the services provided.

4.2 Efficiency of tax administrations in collecting tax revenues

Most national governments choose to impose new taxes and raise the level of tax rates in an effort to increase tax revenues and improve their public finances. However, the solution to reduced tax revenues may come from improving the efficiency of tax administration, reducing the need to increase the tax burden on citizens (Barrillao-Gonzalez et al., 2016). This implies that the tax authorities must develop effective operational planning and management practices. This could be done by adopting best practice by other countries' tax administrations and an effective combination of factors aimed at improving the level of tax compliance, minimising compliance costs, rationalising the operating costs of tax services and linking them to results, the adequate investment and further training and adaptation to new technologies related to the modernisation of tax services (Keehley et al., 1997). The next step will be to improve the scale efficiency of tax administration by increasing the scale operations through internal development. The assessment of a tax system should therefore not be confined to the fiscal policy pursued and the quantification of the results, but should take into account the effectiveness and adequacy of the tax administration which is responsible for monitoring and implementing the financial management measures (Jiménez and Barrilao, 2001). In this sense, the tendency to reduce budget deficits by increasing the tax burden could be replaced by a more rigorous control of the management of the tax system, increasing its effectiveness, while reducing the level of tax fraud (Rubio Guerrero, 2010; Ruibal, 2008).

For the evaluation of the efficiency of tax administrations in the field of collection of tax revenues, the introduction of the following input and output parameters in the DEA model was chosen:

Inputs

- 1 total operating expenditure of the tax administration / total net revenue collected by the tax administration (%)
- 2 number of tax payments
- 3 time to comply in hours
- 4 total year-end tax appears / total net revenue collected (%)
- 5 total year-end tax debt / total tax debt at year beginning (including non-collectible debt) in %

6 total tax and contribution rate (%).

Outputs

1 revenue collected to GDP (%)

2 percentage of staff in enforced debt collections and related functions.

The above-mentioned input to output ratio selected for the DEA, focuses on the analysis of factors that shape the level of tax revenue collection, given that the recent fiscal developments of increasing deficits and the expansion of the level of public debt, as a result of the economic recession prevailing over the past decade, created additional problems in the functioning of tax administrations in developed countries, as they were forced on the one hand to increase the level of tax revenue collected, mainly through the intensification of the use of forced collection methods and reducing the level of taxpayers' arrears, and, on the other hand, to reduce the level of operating costs as a percentage of the tax revenue collected (Jibril, 2020). Furthermore, an important element in combating tax evasion is the stability of tax laws and procedures which make it easier and less costly for taxpayers to comply with their obligations towards tax authorities. It has been observed that taxpayers are less likely to comply voluntarily if the tax system itself makes it too difficult or too expensive to fulfil their obligations, requiring compliance time and costs. In addition, tax rate differentiations, exemptions and tax reductions complicate the system and create scope for tax avoidance (Jensen and Wöhlbier, 2012).

For the reasons mentioned above, it is considered important to introduce into the DEA model the variables related to the level of arrears, as an element of the effort to increase tax revenues in periods of shrinking economic activity, and to the total operating costs of tax administration due to the constraints encountered at the level of funding and available resources, as it is required to achieve more with less means (Jibril, 2020). Also, the inputs referring to the time of compliance and the number of payments represent the degree of ease of the taxpayers to comply with the payment of their tax obligations, making this less time-consuming and costly, while the introduction in the model of the variable that represents the level of tax and contribution rates is considered to represent the level of stability of the tax system over time and the degree of complexity, to exclude cases of tax evasion and loss of tax revenue.

4.3 Efficiency of tax administrations in enhancing voluntary tax compliance

Non-tax compliance is expected to increase if taxpayers do not trust the tax administration to collect the tax correctly and, more generally, if there is a lack of confidence in the government to spend the tax revenues properly (Barone and Mocetti, 2009). Therefore, a crucial element in establishing confidence is the development of tax collection procedures in a transparent manner and the emergence of the correctness of the approximate method followed by the tax administration (Walsh, 2012). Under these circumstances, the criterion of justice is met, as expressed by the way the citizen is treated by the tax administration individually and his perception of the fairness of the tax system in general (i.e., whether others also pay their fair share) (Alm et al., 2010; Reeson and Dunstall, 2009). In addition, a 'service a client' approach by tax administration is very likely to encourage confidence, unlike a corresponding 'cops and robbers' approach based mainly on the imposition of sanctions (Kirchler, 2007). Moreover, the clarity and

simplicity of tax rules is an important way of encouraging tax compliance. Excessively complicated tax systems are associated with high tax evasion. If the tax administration reduces complexity, it will lead to improvements in taxpayers' behaviour (Reeson and Dunstall, 2009; Alm et al., 2010).

Furthermore, the creation of databases containing information on taxpayers' income and assets can make an effective contribution to tax investigations. In this way, taxpayers can be divided into categories of compliance, where the level of risk of non-compliance of each category will depend, *inter alia*, on third party information coverage, so that taxpayers with income and deductions covered extensively by third party information will be classified as 'compliant'. The better the third party information coverage, the more resources are freed up that can be channelled into other areas of action of the tax administration. However, the efficient operation of the third party reporting tool requires tax administrations to use a certain level of IT systems to handle the data and to feed the tax data of the taxpayer's tax returns and an integrated taxpayers' registration system. Has it been shown in practice that the pre-filled (according to third party information) tax returns is a successful process of improving the efficiency of tax collection mainly on PIT (Jensen and Wöhlbier, 2012; OECD, 2013). However, third party information cannot cover all taxpayers and all types of income. In particular, companies and the self-employed will have to a large extent to assess their own income and the expenses deducted from it.

Another important element in the fight against tax evasion is the simple and stable tax laws and procedures which make it easier and less costly for taxpayers to comply with their obligations towards tax authorities. It has been observed that taxpayers are less likely to voluntarily comply if the tax system itself makes it too difficult or too expensive to fulfil their obligations, requiring time and expense. Furthermore, the differentiation of tax rates, the tax exemptions and reductions complicate the tax system and create margins for tax avoidance. As a general rule, tax bases should be broad and allow only limited scope for exemptions and tax systems should tax the substitute income types in a similar way (Jensen and Wöhlbier, 2012).

To assess the efficiency of tax administrations in the area of strengthening voluntary compliance, the following input and output parameters have been selected in the DEA model:

Inputs

- 1 time to comply in hours
- 2 total tax and contribution rate (%)
- 3 number of tax payments.

Outputs

- 1 CIT: On time filing rates of tax returns (tax returns on time / tax returns expected).
- 2 PIT: On time filing rates of tax returns (tax returns on time / tax returns expected).
- 3 Value added tax (VAT): On time filing rates of tax returns (tax returns on time / tax returns expected).
- 4 Percentage of PIT: tax returns prefilled with income information.

5 Cost of investment in IT systems (IT cost) / total operating expenditure of the tax administration (%).

The above mentioned input and output relationship selected for the DEA, focuses on the analysis of factors that affect the level of voluntary compliance of taxpayers, as the inputs referring to the compliance time and number of tax payments represent the degree to which taxpayers are facilitated to comply voluntarily with their tax obligations, the fulfilment of which becomes less costly and time consuming, which can be reflected as an output from the level of income tax returns (by tax category CIT and PIT) and VAT, which are submitted on time. Also the introduction of the variable referring to the percentage of income tax returns pre-filled with third party information, is considered to be an important parameter of the analysis, since the creation of databases on taxpayers' income and assets contributes effectively to the investigations of tax authorities, allowing the separation of taxpayers into compliance categories where the level of risk of non-compliance of each category will depend, inter alia, on the coverage of third party information, so that taxpayers with income and deductions covered extensively by third party information, are classified as 'compliant', thereby increasing the level of voluntary compliance (Jensen and Wöhlbier, 2012; OECD, 2013). Furthermore, the efficient operation of the third-party reporting tool requires tax administrations to use an increased level of IT systems to manipulate information and feed tax returns data, which is reflected by the introduction of the variable referring to the cost of investment of the tax administration in IT systems.

4.4 Efficiency of tax administrations with regard to tax audits

The aim of most tax administrations is to ensure that citizens comply with tax laws and to improve service procedures by treating taxpayers as customers, as already mentioned. In this context, a better understanding of taxpayers' motivations and their attitude towards taxes, may improve both voluntary tax compliance and the efficiency of the tax administration in the enforcement of tax legislation. In this context, the main activity undertaken by the tax authorities in trying to achieve high levels of tax compliance, is tax audit. It is estimated that 40% of tax administrations devote more than 30% of their human resources to procedures for auditing and verifying citizens' tax data. The resources allocated to control activities and their contribution to the levels of revenue and compliance are therefore of particular interest to tax administrations.

Bibliography on taxpayers' behaviour and compliance with tax law (Allingham and Sandmo, 1972; Pentland and Carlile, 1996; Alm, 1999; Feld and Frey, 2002; Torgler, 2003; Wenzel, 2004; Cummings et al., 2005; OECD, 2006, 2010, 2019; Kirchler, 2007; Appelgren, 2008; Khadijah and Pope, 2011) confirms that the attitude of tax inspectors in conducting a tax audit may affect taxpayers' behaviour. Therefore, the assessment of the tax authorities' efficiency in conducting targeted tax audits on the basis of risk analysis criteria and their hit rates in terms of the proportion of the number of audits performed and the magnitude of the hidden taxable material revealed, is a crucial factor for the tax administration's success.

To assess the efficiency of tax administrations in the area of tax audits, the following input and output parameters have been selected in the DEA model:

Inputs

- 1 total operating costs of the tax administration / total net revenue collected by the tax administration (%)
- 2 percentage of staff in enforced debt collections and related functions
- 3 Time to comply with a CIT audit in hours: Time required to correct an error in the CIT return and, if there is a probability of a tax audit, greater than 25%, the time required to prepare and submit data and information for the audit.
- 4 percentage of staff allocated to taxpayers' service and ICT services.

Outputs

- 1 Hit rate of audits: Number of audits where a tax adjustment was made / number of audits completed (%).
- 2 training cost / total operating expenditure (%)
- 3 percentage of staff allocated to audit, investigation and other verification
- 4 ICT cost / total operating expenditure (%).

In determining the input and output relationship introduced in the DEA model, the allocation of staff to the main functions of tax audits, enforced debt collections, taxpayers service and the operation of the tax administration's IT systems, was taken into account as an element of staff specialisation and allocation of human resources, while the introduction of the parameter concerning the operating costs of the tax administration as a factor of rational management of the available financing resources of its operation was considered important. Also, an important element of targeted tax audits is the time required to prepare and submit audit data, in a way that ensures the saving of time for completion of the audit and the auditors who will deal with it. Furthermore, the success rate of the audits as an output of the tax administration's system represents, on the one hand, the level of effectiveness of the tax administration's audit procedures, in the sense that the audits carried out result in the disclosure of undeclared income and, on the other hand the degree of development of an integrated system of targeted tax audits with the establishment of risk analysis criteria and cross-checking of information, elements which presuppose the continuous training of employees and investment in advanced information systems, parameters which are introduced in the model as outputs.

In the DEA models, the number of degrees of freedom will increase with the number of DMUs and decrease with the number of inputs and outputs. A rule of thumb that can provide guidance is as follows Cooper et al. (2007), $n \geq \max\{m \times s, 3 \times (m + s)\}$, where m: number of inputs, s: number of outputs and n: number of DMUs This pre-condition has been fulfilled by the analysis in this paper.

5 Empirical results

The following sections present the results of the implementation of the CCR output-oriented DEA model, in the evaluation objects of the tax administrations of the 26 European countries under investigation.

5.1 *Measuring the efficiency of tax administrations in serving of taxpayers*

The application of the output-oriented CCR model, with regard to the level of services provided by the tax authorities to taxpayers, has produced the results presented in Table 1, the analysis of which leads to the following findings:

Of the 26 tax administrations involved in the survey, 11 of them are fully efficient. In particular, the tax administrations of Croatia, the Czech Republic, Denmark, Finland, Italy, Lithuania, Malta, Portugal, the Slovak Republic, Spain and Sweden show relative efficiency equal to the unit and are fully efficient. The lowest levels of relative efficiency are presented by the tax administrations of Romania (64.28%), Slovenia (64.33%), Bulgaria (68.45%), Cyprus (71.51%) and Belgium (76.97%). The remaining tax administrations show relative efficiency levels of more than 80%, while four of them (Austria, Ireland, Latvia and the UK) record efficiency levels of more than 90%, however they are characterised as inefficient. The average efficiency of the 26 tax administrations is estimated at 90.15%. As for the characterised inefficient tax administrations, the ranking indicates that for the resources they have, the results they present are not satisfactory and therefore they can improve their efficiency by reducing the waste of resources.

Furthermore in Table 1, the reference set and shadow values are presented, where for each inefficient tax administration all efficient tax administrations whose performance is used to calculate its relative efficiency are recorded. From the frequency of emergence of each efficient tax administration as a reference unit for inefficient tax administrations, we find that the tax administrations of Italy and Croatia are the most efficient tax administrations for the formation of the efficiency frontier. Furthermore, the results show that the tax administrations of the Czech Republic, Finland, Lithuania and the Slovak Republic are shown to have a relative efficiency of one, but never appear as benchmarks of other inefficient tax administrations, indicating that they are not in fact fully efficient units.

In Tables 2, 3 and 4, present the results of the resolution of the CCR model with the slacks that can be made to improve the efficiency of inefficient tax administrations. In essence, slacks represent the remaining parts of inefficiency. After a proportional reduction in inputs or an increase in outputs, if a unit cannot reach the efficiency target, the slacks are required to push the unit to the efficiency frontier. Furthermore, the same tables define the targets of inefficient tax administrations, which correspond to a reduction in inputs or an increase in outputs, which will lead the inefficient units to improve their efficiency. They are essentially the coordinates of the virtual unit which is on the efficiency frontier. The percentage difference between the actual level of each input or output and the level of the target set (differences %), is also recorded.

Table 1 Servicing of taxpayers: results of resolution of the CCR (output-oriented) model – relative efficiency – reference set

DMU	Score	Rank	Croatia	Denmark	Italy	Malta	Portugal	Spain	Sweden
Austria	0.93	15		0.034522	0.462038	0.501061			
Belgium	0.77	22	0.269076		0.601505		0.131713		
Bulgaria	0.68	24	0.277507		0.688662				
Croatia	1.00	1	1						
Cyprus	0.72	23	0.125063		0.133139	0.735359			
Czech Republic	1.00	1							
Denmark	1.00	1		1.00					
Estonia	0.90	16	0.200006		0.732764		0.086105		0.061882
Finland	1.00	1							
France	0.82	21	0.301135					0.701042	
Germany	0.87	18	0.064434		0.215996	0.69172	0.048259		0.017313
Greece	0.83	20	0.06813	0.603371			0.350986		
Hungary	0.85	19	0.199706		0.807869				
Ireland	0.95	14	0.145443		0.193621	0.122479	0.549609		
Italy	1.00	1			1.00				
Latvia	0.98	13	0.398668		0.094278	0.21389	0.052183		0.26701
Lithuania	1.00	1							
Malta	1.00	1				1.00			
Netherlands	0.89	17		0.331684	0.413482	0.268529			
Portugal	1.00	1					1.00		
Romania	0.64	26	0.887619		0.046796				
Slovak Republic	1.00	1							
Slovenia	0.64	25			1.00			1.00	
Spain	1.00	1							
Sweden	1.00	1							1.00
UK	0.98	12		0.445516	0.44532	0.104644			

Table 2 Servicing of taxpayers: results of resolution of the CCR (output-oriented) model – slacks – targets

DMU	Score	Input 1 (salary cost/total operating expenditure (%))			Input 2 (percentage of staff allocated to audit, investigation and other verification)			Input 3 (percentage of staff in enforced debt collections and related functions)					
		Actual	Target	Slacks	Differences (%)	Actual	Target	Slacks	Differences (%)	Actual	Target	Slacks	Differences (%)
Austria	0.93	69.77	69.77	0.00	0.00	49.97	31.97	17.99	-36.01	5.08	5.08	0.00	0.00
Belgium	0.77	80.33	80.33	0.00	0.00	38.91	38.91	0.00	0.00	10.04	9.09	0.95	-9.50
Bulgaria	0.68	83.50	83.50	0.00	0.00	44.81	44.81	0.00	0.00	10.02	8.62	1.34	-13.97
Croatia	1.00	62.60	62.60	0.00	0.00	20.54	20.54	0.00	0.00	13.12	13.12	0.00	0.00
Cyprus	0.72	96.09	96.09	0.00	0.00	32.60	32.60	0.00	0.00	9.06	9.06	0.00	0.00
Czech Rep.	1.00	61.01	61.01	0.00	0.00	20.58	20.58	0.00	0.00	6.11	6.11	0.00	0.00
Denmark	1.00	64.27	64.27	0.00	0.00	31.30	31.30	0.00	0.00	13.66	13.66	0.00	0.00
Estonia	0.90	74.04	74.04	0.00	0.00	38.66	38.66	0.00	0.00	6.30	6.30	0.00	0.00
Finland	1.00	60.34	60.34	0.00	0.00	22.65	22.65	0.00	0.00	2.70	2.70	0.00	0.00
France	0.82	92.00	92.00	0.00	0.00	24.29	24.29	0.00	0.00	19.63	19.28	0.35	-1.76
Germany	0.87	82.66	82.66	0.00	0.00	29.70	29.70	0.00	0.00	7.20	7.20	0.00	0.00
Greece	0.83	85.14	85.14	0.00	0.00	33.00	33.00	0.00	0.00	18.00	16.69	1.31	-7.28
Hungary	0.85	69.99	69.99	0.00	0.00	39.50	39.50	0.00	0.00	23.89	8.44	15.45	-64.67
Ireland	0.95	75.24	75.24	0.00	0.00	24.68	24.68	0.00	0.00	10.56	10.56	0.00	0.00
Italy	1.00	57.78	57.78	0.00	0.00	36.27	36.27	0.00	0.00	2.64	2.64	0.00	0.00
Latvia	0.98	72.29	72.29	0.00	0.00	27.63	27.63	0.00	0.00	7.62	7.62	0.00	0.00
Lithuania	1.00	83.97	83.97	0.00	0.00	29.12	29.12	0.00	0.00	5.98	5.98	0.00	0.00
Malta	1.00	72.35	72.35	0.00	0.00	21.65	21.65	0.00	0.00	6.10	6.10	0.00	0.00
Netherlands	0.89	72.74	72.74	0.00	0.00	37.78	35.41	2.37	-6.28	8.17	8.17	0.00	0.00
Portugal	1.00	77.67	77.67	0.00	0.00	19.84	19.84	0.00	0.00	12.58	12.58	0.00	0.00
Romania	0.64	90.64	90.64	0.00	0.00	31.00	31.00	0.00	0.00	19.66	18.79	0.87	-4.41
Slovak Rep.	1.00	86.40	86.40	0.00	0.00	22.56	22.56	0.00	0.00	4.08	4.08	0.00	0.00
Slovenia	0.64	89.82	89.82	0.00	0.00	57.45	56.75	0.70	-1.21	15.95	8.33	7.62	-47.78
Spain	1.00	80.43	80.43	0.00	0.00	19.51	19.51	0.00	0.00	16.77	16.77	0.00	0.00
Sweden	1.00	77.25	77.25	0.00	0.00	36.31	36.31	0.00	0.00	0.00	0.00	0.00	0.00
UK	0.98	63.19	63.19	0.00	0.00	39.45	33.15	6.30	-15.98	8.06	8.06	0.00	0.00

Table 3 Servicing of taxpayers: results of resolution of the CCR (output-oriented) model – slacks – targets

DMU	Score	Output 1 (ICT cost/total operating expenditure (%))				Output 2 (electronic return/filing CIT (%))			
		Actual	Target	Slacks	Differences (%)	Actual	Target	Slacks	Differences (%)
Austria	0.93	17.17	17.17	0.00	0.00	97.21	97.21	0.00	0.00
Belgium	0.77	4.87	8.34	3.53	72.47	99.21	99.21	0.00	0.00
Bulgaria	0.68	2.92	8.28	5.36	183.51	67.71	95.56	27.85	41.13
Croatia	1.00	16.12	16.12	0.00	0.00	96.21	96.21	0.00	0.00
Cyprus	0.72	1.83	22.99	21.16	1,156.15	95.13	95.13	0.00	0.00
Czech Rep.	1.00	8.06	8.06	0.00	0.00	39.98	39.98	0.00	0.00
Denmark	1.00	24.10	24.10	0.00	0.00	100.00	100.00	0.00	0.00
Estonia	0.90	0.35	9.03	8.68	2,478.79	100.00	100.00	0.00	0.00
Finland	1.00	24.16	24.16	0.00	0.00	54.30	54.30	0.00	0.00
France	0.82	5.07	8.48	3.41	67.24	89.73	99.07	9.35	10.42
Germany	0.87	6.21	21.89	15.68	252.45	100.00	100.00	0.00	0.00
Greece	0.83	0.27	17.60	17.33	6,419.27	99.62	100.00	0.38	0.38
Hungary	0.85	0.00	7.68	7.68	76,807.67	100.00	100.00	0.00	0.00
Ireland	0.95	9.40	9.86	0.46	4.93	99.94	99.94	0.00	0.00
Italy	1.00	5.52	5.52	0.00	0.00	100.00	100.00	0.00	0.00
Latvia	0.98	9.61	18.61	9.00	93.65	100.00	100.00	0.00	0.00
Lithuania	1.00	6.64	6.64	0.00	0.00	100.00	100.00	0.00	0.00
Malta	1.00	27.52	27.52	0.00	0.00	94.90	94.90	0.00	0.00
Netherlands	0.89	17.67	17.67	0.00	0.00	100.00	100.00	0.00	0.00
Portugal	1.00	5.60	5.60	0.00	0.00	100.00	100.00	0.00	0.00
Romania	0.64	0.00	14.57	14.57	145,691.90	86.60	90.07	3.47	4.01
Slovak Rep.	1.00	13.53	13.53	0.00	0.00	71.88	71.88	0.00	0.00
Slovenia	0.64	2.48	5.52	3.04	122.60	99.99	99.99	0.01	0.01
Spain	1.00	5.17	5.17	0.00	0.00	100.00	100.00	0.00	0.00
Sweden	1.00	20.55	20.55	0.00	0.00	100.00	100.00	0.00	0.00
UK	0.98	16.08	16.08	0.00	0.00	99.01	99.01	0.00	0.00

Table 4 Servicing of taxpayers: results of resolution of the CCR (output-oriented) model – slacks – targets

DMU	Score	Output 3 (electronic return filing PIT (%))			Output 4 (electronic return filing VAT (%))			Output 5 (percentage of staff in taxpayers service and ICT)					
		Actual	Target	Slacks	Differences (%)	Actual	Target	Slacks	Differences (%)	Actual	Target	Slacks	Differences (%)
Austria	0.93	74.27	99.76	25.49	34.32	92.14	99.76	7.62	8.27	28.80	31.62	2.82	9.78
Belgium	0.77	86.30	86.30	0.00	0.00	98.08	100.00	1.92	1.96	37.80	41.04	3.24	8.57
Bulgaria	0.68	35.74	82.26	46.52	130.15	96.42	96.42	0.00	0.00	25.98	37.03	11.05	42.55
Croatia	1.00	48.24	48.24	0.00	0.00	99.28	99.28	0.00	0.00	54.39	54.39	0.00	0.00
Cyprus	0.72	28.28	92.88	64.60	228.44	81.04	99.27	18.23	22.49	22.29	33.66	11.37	51.02
Czech Rep.	1.00	13.86	13.86	0.00	0.00	53.11	53.11	0.00	0.00	42.88	42.88	0.00	0.00
Denmark	1.00	100.00	100.00	0.00	0.00	100.00	100.00	0.00	0.00	43.08	43.08	0.00	0.00
Estonia	0.90	96.16	96.16	0.00	0.00	99.75	100.00	0.25	0.25	42.13	42.13	0.00	0.00
Finland	1.00	88.85	88.85	0.00	0.00	93.00	93.00	0.00	0.00	28.23	28.23	0.00	0.00
France	0.82	52.94	67.72	14.78	27.93	100.00	100.00	0.00	0.00	33.77	41.95	8.18	24.23
Germany	0.87	100.00	100.00	0.00	0.00	100.00	100.00	0.00	0.00	35.20	35.20	0.00	0.00
Greece	0.83	98.71	98.71	0.00	0.00	99.94	100.00	0.06	0.06	49.00	49.00	0.00	0.00
Hungary	0.85	55.40	90.42	35.02	63.21	100.00	100.00	0.00	0.00	36.60	36.60	0.00	0.00
Ireland	0.95	93.58	93.58	0.00	0.00	99.26	100.00	0.74	0.75	44.29	48.07	3.78	8.52
Italy	1.00	100.00	100.00	0.00	0.00	100.00	100.00	0.00	0.00	31.86	31.86	0.00	0.00
Latvia	0.98	75.24	75.24	0.00	0.00	100.00	100.00	0.00	0.00	47.82	47.82	0.00	0.00
Lithuania	1.00	99.83	99.83	0.00	0.00	99.96	99.96	0.00	0.00	51.51	51.51	0.00	0.00
Malta	1.00	100.00	100.00	0.00	0.00	100.00	100.00	0.00	0.00	30.75	30.75	0.00	0.00
Netherlands	0.89	97.69	100.00	2.31	2.36	100.00	100.00	0.00	0.00	29.11	35.73	6.62	22.72
Portugal	1.00	99.98	99.98	0.00	0.00	100.00	100.00	0.00	0.00	54.99	54.99	0.00	0.00
Romania	0.64	31.84	47.50	15.66	49.10	92.80	92.80	0.00	0.00	28.32	49.76	21.44	75.72
Slovak Rep.	1.00	19.15	19.15	0.00	0.00	99.86	99.86	0.00	0.00	39.94	39.94	0.00	0.00
Slovenia	0.64	96.84	99.99	3.16	3.26	100.00	100.00	0.00	0.00	11.74	31.86	20.12	171.41
Spain	1.00	75.89	75.89	0.00	0.00	100.00	100.00	0.00	0.00	36.48	36.48	0.00	0.00
Sweden	1.00	74.80	74.80	0.00	0.00	100.00	100.00	0.00	0.00	51.25	51.25	0.00	0.00
UK	0.98	87.85	99.55	11.70	13.32	99.44	99.55	0.11	0.11	29.85	36.60	6.75	22.61

The analysis of the results of the imposition of slacks show that it is required:

- 1 A reduction of the percentage of staff allocated to audit, investigation and other verification in the tax administrations of Austria by 17.99 points (–36.01% against the target), the Netherlands by 2.37 points (–6.28% against the target), Slovenia by 0.69 points (–1.21% against the target) and the UK by 6.30 points (–15.98% against the target).
- 2 A reduction of the percentage of staff in enforced debt collections and related functions in the tax administrations of Belgium by 0.95 points (–9.5% against the target), Bulgaria by 1.40 points (–13.97% against the target), France by 0.35 points (–1.76% against the target), Greece by 1.31 points (–7.28% against the target), Hungary by 15.45 points (–64.67% against the target), Romania by 0.87 points (–4.41% against the target) and Slovenia by 7.62 points (–47.78% against the target).
- 3 An increase in IT systems cost as a percentage of total operating expenditure, in the tax administrations of Belgium by 3.53 points (+72.47% against the target), Bulgaria by 5.36 points (+183.51% against the target), Cyprus by 21.16 units (+1,156.15% against the target), Estonia 8.68 points (+2,478.79% against the target), France 3.41 points (+67.24% against the target), Germany 15.68 points (+252.45% against the target), Greece by 17.33 points (+6,419.27% against the target), Hungary by 7.68 points (+76,807.67% against the target), Ireland by 0.46 points (+4.93% against the target), Latvia by nine points (+93.65% against the target), Romania by 14.57 points (+145,691.90% against the target) and Slovenia by 3.04 points (+122.60% against the target).
- 4 An increase of the rate of use of electronic filing of tax returns in (CIT) in the tax administrations of Bulgaria by 27.85 points (+41.13% against the target), France by 9.35 points (+10.42% against the target), Greece by 0.38 points (+0.38% against the target), Romania by 3.47 points (+4.01% against the target) and Slovenia by 0.009 points (+0.009% against the target).
- 5 An increase of the rate of use of electronic filing of tax returns in PIT in the tax administrations of Austria by 25.49 points (+34.32% against the target), Bulgaria by 46.52 points (+130.15% against the target), Cyprus by 64.60 points (+228.44 % against the target), France by 14.78 points (+27.93% against the target), Hungary by 35.02 points (+63.21% against the target), the Netherlands by 2.31 points (+2.36% against the target), Romania by 15.66 points (+49.19% against the target), Slovenia by 3.16 points (+3.26% against the target) and the UK by 11.7 points (+13.32% against the target).
- 6 An increase of the rate of use of electronic filing of tax returns in VAT in the tax administrations of Austria by 7.62 points (+8.27% against the target), Belgium by 1.92 points (+1.96% against the target), Cyprus by 18.23 points (+22.49% against the target), Estonia by 0.25 points (+0.25% against the target), Greece by 0.06 points (+0.06% against the target), Ireland by 0.74 points (+0.75% against the target) and the UK by 0.11 points (+0.11% against the target).
- 7 An increase of the percentage of staff allocated to the taxpayers' service and IT systems in tax administrations of Austria by 2.82 points (+9.78% against target), Belgium by 3.24 points (+8.57% against the target), Bulgaria by 11.05 points

(+42.55% against the target), Cyprus by 11.37 points (+51.02% against the target), France by 8.18 points (+24.23% against the target), Hungary by 0.00097 points (+0.002% against the target), Ireland by 3.78 points (+8.52% against the target), the Netherlands by 6.62 points (+22.72% against the target), Romania by 21.44 points (+75.72% against the target), Slovenia by 20.12 points (+171.41% against the target) and the UK by 6.75 points (+22.61% against the target).

5.2 *Measuring the efficiency of tax administrations in collecting tax revenues*

The results of the implementation of the basic CCR output-oriented model, regarding the ability of the tax administrations of the European countries in question to collect tax revenue, are presented in Table 5. From their analysis emerge the following useful conclusions:

The tax administrations of Croatia, Denmark, Estonia, France, Germany, Greece, Hungary, Ireland, Romania, Sweden and the UK, show relative efficiency equal to the unit and are characterised as fully efficient. In addition, the Netherlands (99.33%) and Spain (97.67%) have high levels of efficiency, in contrast to the tax administrations of the Slovak Republic, Italy and Czech Republic, which show the lowest efficiency scores of 35.96%, 42.69% and 46.24%, respectively. The average efficiency of the 26 European tax administrations is estimated at 81.63%.

Furthermore, from the reference set presented in Table 5, it is concluded that the tax administrations of Hungary, Denmark and Sweden are the most crucial effective tax administrations for shaping the efficiency frontier, as they are often presented as benchmarks of other inefficient tax administrations. On the other hand, although the tax administrations of Germany and Ireland appear to be fully efficient, they are never appear as reference units for other inefficient tax administrations. They are, therefore, not essentially fully efficient units.

In addition, a further investigation of the efficiency of inefficient tax administrations, by assessing the lack of output and the excess amount of input (slacks), in order to make them efficient (see Tables 6, 7 and 8), leads us to note that it is required:

- 1 A reduction in the total operating cost as a percentage of the total net revenue collected in the tax administrations of Austria by 0.21 points (−25.62% against the target), Belgium by 0.25 points (−27.28% against the target), Bulgaria by 0.16 points (−16.21% against the target), Cyprus by 0.42 points (−40.26% against target), the Czech Republic by 0.42 points (−31.95% against the target), Finland by 0.20 points (−30.48% against the target), Italy by 0.17 points (−20.28% against the target), Latvia by 0.38 points (−47.61% against the target), Lithuania by 0.10 points (−14.44% against the target), the Netherlands by 0.12 points (−15.71% against the target), Portugal by 0.52 points (−48.37% against the target), the Slovak Republic by 0.22 points (−21.25% against the target) and Slovenia by 0.15 points (−22.29% against the target).
- 2 A reduction in the number of tax payments by 2.01 points in Austria (−16.76% against the target), by 0.96 points in Belgium (−8.71% against the target), by 0.76 points in Bulgaria (−5.45% against the target), by 13 points in Cyprus (−48.17% against the target), by 0.13 points in Finland (−1.61% against the target), by 2.53 points in Italy (−18.07% against the target), by 0.69 points in Lithuania (−6.85%

- against the target), by 0.57 points in the Netherlands (−6.29% against the target) and by 1.09 points in Spain (−12.13% against the target).
- 3 A reduction in time to comply in the tax administrations of Bulgaria by 124.64 hours (−27.51% against the target), the Czech Republic by 17.51 hours (−7.61% against the target), Italy by 25.63 hours (−10.77% against the target), Latvia by 16.04 hours (−9.49% against the target), Portugal 37.51 hours (−15.43% against the target), the Slovak Republic by 1.72 hours (−0.90% against the target), and Slovenia by 36.18 hours (−15.53% against the target).
 - 4 A reduction of the total year-end tax arrears as a percentage of the total net revenue collected by the tax authorities of Austria by 1.51 points (−18.51% against the target), Belgium by 6.03 points (−37.86% against the target), Cyprus by 33.68 points (−61.26% against the target), Finland by 1.10 points (−17.25% against the target), Italy by 78.89 points (−41.77% against the target), Latvia by 8.38 points (−59.39% against the target), Lithuania by 0.07 points (−1.14% against the target), Malta by 54.11 points (−57.93% against the target) and Spain by 3.17 points (−31.56% against the target).
 - 5 A reduction of the total year-end tax debt as a percentage of the total tax debt at the beginning of the year of 2017 by seven points in Bulgaria (−6.95% against the target), by 5.95 points in the Czech Republic (−6.61% against the target), by 8.7 points in Latvia (−9.73% against the target), by 13.98 points in Malta (−12.08% against the target), by 23.64 points in Portugal (−22.82% against the target), by 4.79 points in the Slovak Republic (−4.70% against the target), by 2.71 points in Slovenia (−2.82% the target) and 11.45 points in Spain (−12.73% against the target).
 - 6 A reduction of total tax and contribution rate by 11.03 points in Austria (−21.42% against the target), by 19.88 points in Belgium (−34.46% against the target), by 3.82 points in the Czech Republic (−8.26% against the target), by 0.007 points in Italy (−0.014% against the target), by 1.99 points in Lithuania (−4.68% against the target), by 6.93 points in Malta (−15.79% against the target), by 6.82 points in the Netherlands (−16.72% against the target), by 2.82 points in Portugal (−7.09% against the target), by 2.17 points in the Slovak Republic (−4.36% against the target) and by 2.24 points in Spain (−4.76% against the target).
 - 7 An increase in revenue collected as a percentage of GDP, by 12.16 points in Cyprus (+77.48% against the target) and by 2.6 points in Spain (+16.79% against the target).
 - 8 An increase in the percentage of staff available to forced debt collection procedures and related functions in the Finnish tax administration by 2.64 points (+97.61% against the target).

5.3 Measuring the efficiency of tax administrations in enhancing voluntary tax compliance

Table 9 presents the results of the resolution of the CCR output-oriented DEA model, with regard to the efficiency of tax administrations of the European countries under investigation, in enhancing voluntary tax compliance as expressed through the on time filling rate of tax returns.

Table 6 Collecting of tax revenues: results of resolution of the CCR (output-oriented) model – slacks – targets

DMU	Score	Input 1 (total operating expenditure/total net revenue collected by the tax administration (%))			Input 2 (number of tax payments)			Input 3 (time to comply-in hours)					
		Actual	Target	Slacks	Differences (%)	Actual	Target	Slacks	Differences (%)	Actual	Target	Slacks	Differences (%)
Austria	0.53	0.83	0.62	0.21	-25.62	12.00	9.99	2.01	-16.76	131.00	131.00	0.00	0.00
Belgium	0.69	0.91	0.66	0.25	-27.28	11.00	10.04	0.96	-8.71	136.00	136.00	0.00	0.00
Bulgaria	0.58	1.01	0.84	0.16	-16.21	14.00	13.24	0.76	-5.45	453.00	328.36	124.64	-27.51
Croatia	1.00	0.72	0.72	0.00	0.00	12.00	12.00	0.00	0.00	206.00	206.00	0.00	0.00
Cyprus	0.72	1.05	0.63	0.42	-40.26	27.00	13.99	13.00	-48.17	123.00	123.00	0.00	0.00
Czech Rep.	0.46	1.32	0.90	0.42	-31.95	8.00	8.00	0.00	0.00	230.00	212.49	17.51	-7.61
Denmark	1.00	0.52	0.52	0.00	0.00	10.00	10.00	0.00	0.00	132.00	132.00	0.00	0.00
Estonia	1.00	0.33	0.33	0.00	0.00	8.00	8.00	0.00	0.00	50.00	50.00	0.00	0.00
Finland	0.74	0.65	0.45	0.20	-30.48	8.00	7.87	0.13	-1.61	90.00	90.00	0.00	0.00
France	1.00	0.89	0.89	0.00	0.00	9.00	9.00	0.00	0.00	139.00	139.00	0.00	0.00
Germany	1.00	1.37	1.37	0.00	0.00	9.00	9.00	0.00	0.00	218.00	218.00	0.00	0.00
Greece	1.00	0.60	0.60	0.00	0.00	8.00	8.00	0.00	0.00	193.00	193.00	0.00	0.00
Hungary	1.00	0.54	0.54	0.00	0.00	11.00	11.00	0.00	0.00	277.00	277.00	0.00	0.00
Ireland	1.00	0.54	0.54	0.00	0.00	9.00	9.00	0.00	0.00	81.00	81.00	0.00	0.00
Italy	0.43	0.84	0.67	0.17	-20.28	14.00	11.47	2.53	-18.07	238.00	212.37	25.63	-10.77
Latvia	0.88	0.81	0.42	0.38	-47.61	7.00	7.00	0.00	0.00	169.00	152.96	16.04	-9.49
Lithuania	0.51	0.70	0.60	0.10	-14.44	10.00	9.31	0.69	-6.85	99.00	99.00	0.00	0.00
Malta	0.64	0.42	0.42	0.00	0.00	8.00	8.00	0.00	0.00	139.00	139.00	0.00	0.00
Netherlands	0.99	0.76	0.64	0.12	-15.71	9.00	8.43	0.57	-6.29	119.00	119.00	0.00	0.00
Portugal	0.80	1.08	0.56	0.52	-48.37	8.00	8.00	0.00	0.00	243.00	205.49	37.51	-15.43
Romania	1.00	0.80	0.80	0.00	0.00	14.00	14.00	0.00	0.00	163.00	163.00	0.00	0.00
Slovak Rep.	0.36	1.06	0.83	0.22	-21.25	8.00	8.00	0.00	0.00	192.00	190.28	1.72	-0.90
Slovenia	0.91	0.67	0.52	0.15	-22.29	10.00	10.00	0.00	0.00	233.00	196.82	36.18	-15.53
Spain	0.98	0.64	0.64	0.00	0.00	9.00	7.91	1.09	-12.13	148.00	148.00	0.00	0.00
Sweden	1.00	0.35	0.35	0.00	0.00	6.00	6.00	0.00	0.00	122.00	122.00	0.00	0.00
UK	1.00	0.67	0.67	0.00	0.00	8.00	8.00	0.00	0.00	105.00	105.00	0.00	0.00

Table 7 Collecting of tax revenues: results of resolution of the CCR (output-oriented) model – slacks – targets

DMU	Score	Input 4 (total year-end tax arrears to total net revenue collected (%))			Input 5 (total year-end tax debt / total tax debt at year beginning (including non-collectible debt))			Input 6 (total tax and contribution rate (%))					
		Actual	Target	Slacks	Differences (%)	Actual	Target	Slacks	Differences (%)	Actual	Target	Slacks	Differences (%)
Austria	0.53	8.17	6.66	1.51	-18.51	96.86	96.86	0.00	0.00	51.50	40.47	11.03	-21.42
Belgium	0.69	15.93	9.90	6.03	-37.86	103.77	103.77	0.00	0.00	57.70	37.82	19.88	-34.46
Bulgaria	0.58	24.34	24.34	0.00	0.00	100.69	93.69	7.00	-6.95	27.70	27.70	0.00	0.00
Croatia	1.00	27.49	27.49	0.00	0.00	79.49	79.49	0.00	0.00	20.50	20.50	0.00	0.00
Cyprus	0.72	54.98	21.30	33.68	-61.26	93.57	93.57	0.00	0.00	22.20	22.20	0.00	0.00
Czech Rep.	0.46	6.27	6.27	0.00	0.00	90.09	84.14	5.95	-6.61	46.20	42.38	3.82	-8.26
Denmark	1.00	7.23	7.23	0.00	0.00	109.61	109.61	0.00	0.00	23.90	23.90	0.00	0.00
Estonia	1.00	5.22	5.22	0.00	0.00	97.50	97.50	0.00	0.00	48.60	48.60	0.00	0.00
Finland	0.74	6.38	5.28	1.10	-17.25	96.29	96.29	0.00	0.00	37.30	37.30	0.00	0.00
France	1.00	7.49	7.49	0.00	0.00	100.64	100.64	0.00	0.00	60.50	60.50	0.00	0.00
Germany	1.00	0.99	0.99	0.00	0.00	92.92	92.92	0.00	0.00	49.00	49.00	0.00	0.00
Greece	1.00	212.81	212.81	0.00	0.00	106.40	106.40	0.00	0.00	51.90	51.90	0.00	0.00
Hungary	1.00	10.18	10.18	0.00	0.00	82.43	82.43	0.00	0.00	40.20	40.20	0.00	0.00
Ireland	1.00	3.50	3.50	0.00	0.00	95.94	95.94	0.00	0.00	26.00	26.00	0.00	0.00
Italy	0.43	188.86	109.98	78.88	-41.77	107.45	107.45	0.00	0.00	53.20	53.19	0.01	-0.014
Latvia	0.88	14.12	5.73	8.39	-59.39	89.47	80.77	8.70	-9.73	36.00	36.00	0.00	0.00
Lithuania	0.51	6.40	6.33	0.07	-1.14	98.76	98.76	0.00	0.00	42.60	40.61	1.99	-4.68
Malta	0.64	93.40	39.29	54.11	-57.93	115.68	101.70	13.98	-12.08	43.90	36.97	6.93	-15.79
Netherlands	0.99	2.98	2.98	0.00	0.00	107.48	107.48	0.00	0.00	40.80	33.98	6.82	-16.72
Portugal	0.80	37.00	37.00	0.00	0.00	103.61	79.97	23.64	-22.82	39.80	36.98	2.82	-7.09
Romania	1.00	48.64	48.64	0.00	0.00	104.00	104.00	0.00	0.00	40.00	40.00	0.00	0.00
Slovak Rep.	0.36	21.46	21.46	0.00	0.00	102.02	97.23	4.79	-4.70	49.70	47.53	2.17	-4.36
Slovenia	0.91	8.16	8.16	0.00	0.00	95.94	93.23	2.71	-2.82	31.10	31.10	0.00	0.00
Spain	0.98	10.06	6.89	3.17	-31.56	89.90	78.45	11.45	-12.73	47.00	44.76	2.24	-4.76
Sweden	1.00	1.65	1.65	0.00	0.00	98.84	98.84	0.00	0.00	49.10	49.10	0.00	0.00
UK	1.00	2.30	2.30	0.00	0.00	101.56	101.56	0.00	0.00	30.00	30.00	0.00	0.00

Table 8 Collecting of tax revenues: results of resolution of the CCR (output-oriented) model – slacks – targets

DMU	Score	Output 1 (revenue collected to GDP (%))				Output 2 (percentage of staff in enforced debt collections and related functions)			
		Actual	Target	Slacks	Differences (%)	Actual	Target	Slacks	Differences (%)
Austria	0.53	22.80	22.80	0.00	0.00	5.08	5.08	0.00	0.00
Belgium	0.69	28.00	28.00	0.00	0.00	10.04	10.04	0.00	0.00
Bulgaria	0.58	19.40	19.40	0.00	0.00	10.02	10.02	0.00	0.00
Croatia	1.00	28.30	28.30	0.00	0.00	13.12	13.12	0.00	0.00
Cyprus	0.72	15.70	27.86	12.16	77.48	9.06	9.06	0.00	0.00
Czech Rep.	0.46	15.90	15.90	0.00	0.00	6.11	6.11	0.00	0.00
Denmark	1.00	46.50	46.50	0.00	0.00	13.66	13.66	0.00	0.00
Estonia	1.00	34.10	34.10	0.00	0.00	6.30	6.30	0.00	0.00
Finland	0.74	29.00	29.00	0.00	0.00	2.70	5.34	2.64	97.61
France	1.00	17.50	17.50	0.00	0.00	19.63	19.63	0.00	0.00
Germany	1.00	18.50	18.50	0.00	0.00	7.20	7.20	0.00	0.00
Greece	1.00	25.00	25.00	0.00	0.00	18.00	18.00	0.00	0.00
Hungary	1.00	34.40	34.40	0.00	0.00	23.89	23.89	0.00	0.00
Ireland	1.00	20.70	20.70	0.00	0.00	10.56	10.56	0.00	0.00
Italy	0.43	21.70	21.70	0.00	0.00	2.64	2.64	0.00	0.00
Latvia	0.88	31.90	31.90	0.00	0.00	7.62	7.62	0.00	0.00
Lithuania	0.51	17.60	17.60	0.00	0.00	5.98	5.98	0.00	0.00
Malta	0.64	26.50	26.50	0.00	0.00	6.10	6.10	0.00	0.00
Netherlands	0.99	33.30	33.30	0.00	0.00	8.17	8.17	0.00	0.00
Portugal	0.80	23.30	23.30	0.00	0.00	12.58	12.58	0.00	0.00
Romania	1.00	24.00	24.00	0.00	0.00	19.66	19.66	0.00	0.00
Slovak Rep.	0.36	13.90	13.90	0.00	0.00	4.08	4.08	0.00	0.00
Slovenia	0.91	35.60	35.60	0.00	0.00	15.95	15.95	0.00	0.00
Spain	0.98	15.50	18.10	2.60	16.79	16.77	16.77	0.00	0.00
Sweden	1.00	48.20	48.20	0.00	0.00	0.00	0.00	0.00	0.00
UK	1.00	26.80	26.80	0.00	0.00	8.06	8.06	0.00	0.00

Table 10 Enhancing of voluntary tax compliance: results of resolution of the CCR (output-oriented) model – slacks – targets

DMU	Score	Input 1 (time to comply – in hours)			Input 2 (total tax and contribution rate (%))			Input 3 (number of tax payments)					
		Actual	Target	Slacks	Differences (%)	Actual	Target	Slacks	Differences (%)	Actual	Target	Slacks	Differences (%)
Austria	0.63	131.00	131.00	0.00	0.00	51.50	51.50	0.00	0.00	12.00	12.00	0.00	0.00
Belgium	0.72	136.00	136.00	0.00	0.00	57.70	57.70	0.00	0.00	11.00	11.00	0.00	0.00
Bulgaria	0.90	453.00	237.94	215.06	-47.47	27.70	27.70	0.00	0.00	14.00	14.00	0.00	0.00
Croatia	1.00	206.00	206.00	0.00	0.00	20.50	20.50	0.00	0.00	12.00	12.00	0.00	0.00
Cyprus	1.00	123.00	123.00	0.00	0.00	22.20	22.20	0.00	0.00	27.00	27.00	0.00	0.00
Czech Rep.	0.87	230.00	163.97	66.03	-28.71	46.20	46.20	0.00	0.00	8.00	8.00	0.00	0.00
Denmark	1.00	132.00	132.00	0.00	0.00	23.90	23.90	0.00	0.00	10.00	10.00	0.00	0.00
Estonia	1.00	50.00	50.00	0.00	0.00	48.60	48.60	0.00	0.00	8.00	8.00	0.00	0.00
Finland	1.00	90.00	90.00	0.00	0.00	37.30	37.30	0.00	0.00	8.00	8.00	0.00	0.00
France	0.78	139.00	139.00	0.00	0.00	60.50	60.50	0.00	0.00	9.00	9.00	0.00	0.00
Germany	0.81	218.00	182.39	35.61	-16.34	49.00	49.00	0.00	0.00	9.00	9.00	0.00	0.00
Greece	0.85	193.00	150.49	42.51	-22.03	51.90	51.90	0.00	0.00	8.00	8.00	0.00	0.00
Hungary	0.79	277.00	185.99	91.01	-32.85	40.20	40.20	0.00	0.00	11.00	11.00	0.00	0.00
Ireland	1.00	81.00	81.00	0.00	0.00	26.00	26.00	0.00	0.00	9.00	9.00	0.00	0.00
Italy	0.63	238.00	219.99	18.01	-7.57	53.20	53.20	0.00	0.00	14.00	14.00	0.00	0.00
Latvia	1.00	169.00	169.00	0.00	0.00	36.00	36.00	0.00	0.00	7.00	7.00	0.00	0.00
Lithuania	0.89	99.00	99.00	0.00	0.00	42.60	42.60	0.00	0.00	10.00	10.00	0.00	0.00
Malta	1.00	139.00	139.00	0.00	0.00	43.90	43.90	0.00	0.00	8.00	8.00	0.00	0.00
Netherlands	0.90	119.00	119.00	0.00	0.00	40.80	40.80	0.00	0.00	9.00	9.00	0.00	0.00
Portugal	0.98	243.00	129.80	113.20	-46.59	39.80	39.80	0.00	0.00	8.00	8.00	0.00	0.00
Romania	0.70	163.00	163.00	0.00	0.00	40.00	40.00	0.00	0.00	14.00	13.26	0.74	-5.29
Slovak Rep.	0.81	192.00	182.91	9.09	-4.73	49.70	49.70	0.00	0.00	8.00	8.00	0.00	0.00
Slovenia	0.91	233.00	143.67	89.33	-38.34	31.10	31.10	0.00	0.00	10.00	10.00	0.00	0.00
Spain	0.85	148.00	146.46	1.54	-1.04	47.00	47.00	0.00	0.00	9.00	9.00	0.00	0.00
Sweden	1.00	122.00	122.00	0.00	0.00	49.10	49.10	0.00	0.00	6.00	6.00	0.00	0.00
UK	1.00	105.00	105.00	0.00	0.00	30.00	30.00	0.00	0.00	8.00	8.00	0.00	0.00

Table 11 Enhancing of voluntary tax compliance: results of resolution of the CCR (output-oriented) model – slacks – targets

DMU	Score	Output 1 (CIT on time filing rates (return on time/return expected))				Output 2 (PIT on time filing rates (return on time/return expected))			
		Actual	Target	Slacks	Differences (%)	Actual	Target	Slacks	Differences (%)
Austria	0.63	75.92	83.45	7.53	9.92	75.25	87.88	12.63	16.79
Belgium	0.72	80.26	88.27	8.01	9.99	92.90	95.39	2.49	2.68
Bulgaria	0.90	73.56	91.47	17.91	24.35	86.73	97.44	10.71	12.35
Croatia	1.00	87.35	87.35	0.00	0.00	88.84	88.84	0.00	0.00
Cyprus	1.00	36.04	36.04	0.00	0.00	80.10	80.10	0.00	0.00
Czech Rep.	0.87	90.03	90.03	0.00	0.00	97.07	97.07	0.00	0.00
Denmark	1.00	90.35	90.35	0.00	0.00	99.77	99.77	0.00	0.00
Estonia	1.00	95.50	95.50	0.00	0.00	96.20	96.20	0.00	0.00
Finland	1.00	94.75	94.75	0.00	0.00	97.46	97.46	0.00	0.00
France	0.78	95.45	95.45	0.00	0.00	97.52	98.79	1.27	1.30
Germany	0.81	76.68	82.34	5.66	7.38	86.51	96.55	10.04	11.61
Greece	0.85	93.91	97.65	3.74	3.98	99.11	99.11	0.00	0.00
Hungary	0.79	83.85	92.68	8.83	10.54	91.10	99.56	8.46	9.28
Ireland	1.00	64.61	64.61	0.00	0.00	79.46	79.46	0.00	0.00
Italy	0.63	97.78	97.78	0.00	0.00	99.26	100.00	0.74	0.75
Latvia	1.00	73.34	73.34	0.00	0.00	95.30	95.30	0.00	0.00
Lithuania	0.89	61.80	83.07	21.27	34.42	82.21	93.09	10.88	13.24
Malta	1.00	82.60	82.60	0.00	0.00	85.20	85.20	0.00	0.00
Netherlands	0.90	95.00	96.43	1.43	1.51	98.72	98.72	0.00	0.00
Portugal	0.98	98.42	98.42	0.00	0.00	97.81	100.00	2.19	2.24
Romania	0.70	92.08	92.08	0.00	0.00	72.24	96.69	24.45	33.85
Slovak Rep.	0.81	81.54	81.54	0.00	0.00	76.45	94.76	18.31	23.95
Slovenia	0.91	94.02	94.02	0.00	0.00	83.24	98.66	15.42	18.52
Spain	0.85	100.00	100.00	0.00	0.00	100.00	100.00	0.00	0.00
Sweden	1.00	97.70	97.70	0.00	0.00	99.10	99.10	0.00	0.00
UK	1.00	95.18	95.18	0.00	0.00	93.53	93.53	0.00	0.00

Table 12 Enhancing of voluntary tax compliance: results of resolution of the CCR (output-oriented) model -slack – targets

DMU	Score	Output 3 (VAT on time filing rates (return on time/return expected))				Output 4 (percentage of PIT tax returns prefiled with income information)			
		Actual	Target	Slacks	Differences (%)	Actual	Target	Slacks	Differences (%)
Austria	0.63	75.50	84.32	8.82	11.68	91.20	91.20	0.00	0.00
Belgium	0.72	99.18	99.18	0.00	0.00	31.90	100.00	68.10	213.48
Bulgaria	0.90	98.79	98.79	0.00	0.00	0.00	100.00	100.00	1,000.00
Croatia	1.00	86.58	86.58	0.00	0.00	100.00	100.00	0.00	0.00
Cyprus	1.00	87.00	87.00	0.00	0.00	0.00	0.00	0.00	0.00
Czech Rep.	0.87	90.60	95.99	5.39	5.95	0.00	89.53	89.53	895,288.20
Denmark	1.00	87.06	87.06	0.00	0.00	100.00	100.00	0.00	0.00
Estonia	1.00	91.27	91.27	0.00	0.00	100.00	100.00	0.00	0.00
Finland	1.00	91.23	91.23	0.00	0.00	100.00	100.00	0.00	0.00
France	0.78	100.00	100.00	0.00	0.00	100.00	100.00	0.00	0.00
Germany	0.81	100.00	100.00	0.00	0.00	88.90	88.90	0.00	0.00
Greece	0.85	92.90	97.25	4.35	4.68	98.70	98.70	0.00	0.00
Hungary	0.79	88.50	91.17	2.67	3.02	100.00	100.00	0.00	0.00
Ireland	1.00	89.38	89.38	0.00	0.00	88.90	88.90	0.00	0.00
Italy	0.63	95.94	95.94	0.00	0.00	100.00	100.00	0.00	0.00
Latvia	1.00	97.66	97.66	0.00	0.00	75.23	75.23	0.00	0.00
Lithuania	0.89	98.51	98.51	0.00	0.00	100.00	100.00	0.00	0.00
Malta	1.00	89.64	89.64	0.00	0.00	77.39	77.39	0.00	0.00
Netherlands	0.90	95.30	95.30	0.00	0.00	80.50	98.23	17.73	22.02
Portugal	0.98	94.85	96.02	1.17	1.24	100.00	100.00	0.00	0.00
Romania	0.70	89.32	89.32	0.00	0.00	0.00	95.11	95.11	951,124.30
Slovak Rep.	0.81	96.37	96.37	0.00	0.00	0.00	83.43	83.43	834.30
Slovenia	0.91	84.62	88.58	3.96	4.68	96.60	96.60	0.00	0.00
Spain	0.85	97.57	97.57	0.00	0.00	75.90	96.83	20.93	27.57
Sweden	1.00	100.00	100.00	0.00	0.00	100.00	100.00	0.00	0.00
UK	1.00	85.71	85.71	0.00	0.00	87.90	87.90	0.00	0.00

Table 13 Enhancing of voluntary tax compliance: results of resolution of the CCR (output-oriented) model – slacks – targets

<i>DMU</i>	<i>Score</i>	<i>Output 5 (ICT cost/total operating expenditure (%))</i>			
		<i>Actual</i>	<i>Target</i>	<i>Slacks</i>	<i>Differences (%)</i>
Austria	0.63	17.17	20.27	3.10	18.04
Belgium	0.72	4.87	13.33	8.46	173.68
Bulgaria	0.90	2.92	16.07	13.15	450.40
Croatia	1	16.12	16.12	0.00	0.00
Cyprus	1	1.83	1.83	0.00	0.00
Czech Rep.	0.87	8.06	15.99	7.94	98.46
Denmark	1	24.10	24.10	0.00	0.00
Estonia	1	0.35	0.35	0.00	0.00
Finland	1	24.16	24.16	0.00	0.00
France	0.78	5.07	16.42	11.35	223.96
Germany	0.81	6.21	13.63	7.42	119.46
Greece	0.85	0.27	20.18	19.91	7.374.13
Hungary	0.79	0.00	22.97	22.97	229.725.90
Ireland	1	9.40	9.40	0.00	0.00
Italy	0.63	5.52	20.80	15.28	276.81
Latvia	1	9.61	9.61	0.00	0.00
Lithuania	0.89	6.64	10.12	3.48	52.46
Malta	1	27.52	27.52	0.00	0.00
Netherlands	0.90	17.67	18.80	1.13	6.39
Portugal	0.98	5.60	20.91	15.31	273.41
Romania	0.70	0.00	18.56	18.56	185,567.70
Slovak Rep.	0.81	13.53	13.74	0.21	1.53
Slovenia	0.91	2.48	21.02	18.54	747.70
Spain	0.85	5.17	18.22	13.05	252.35
Sweden	1	20.55	20.55	0.00	0.00
UK	1	16.08	16.08	0.00	0.00

The analysis of the results shows that the tax administrations of Croatia, Cyprus, Denmark, Estonia, Finland, Ireland, Latvia, Malta, Sweden and the UK, are considered to be fully efficient, in contrast to the others which show relative efficiency below the unit and are considered inefficient. Furthermore, the evaluation of the efficiency scores of the inefficient units shows a high level of efficiency for the tax administrations of Portugal (97.59%), Slovenia (90.9%), the Netherlands (90.45%) and Bulgaria (90.04%), which is considered high but not sufficient to be fully efficient. The other inefficient tax administrations show efficiency scores from 63.45% to 88.52%, with the lowest recorded in the tax administrations of Italy (63.45%) and Austria (63.45%). The average efficiency of the 26 tax administrations is estimated at 88.52%.

In addition, the analysis of the reference set shows that the Swedish tax administration appears as a reference unit in many inefficient tax administrations, which

indicates that it is the most decisive efficient unit forming the efficiency frontier. In contrast to the above, although the tax administrations of Cyprus and Malta appear to be fully efficient, they are not reference units for other inefficient tax administrations, so that they are not essentially fully efficient units.

As for the additional improvement (increase of outputs and decrease of inputs) required in order for inefficient tax administrations to become more efficient, in the sense of assessing the missing amount of outputs and the excess amount of inputs, the application of the CCR model has shown (see Tables 10, 11, 12 and 13) that it is necessary:

- 1 A reduction of compliance time in tax administrations of Bulgaria by 215.05 hours (–47.47% against the target), the Czech Republic by 66.02 hours (–28.71% against the target), Germany by 35.61 hours (–16.34% against the target), Greece by 42.51 hours (–22.03% against the target), Hungary by 91 hours (–32.85% against the target), Italy by 18 hours (–7.57% against the target), Portugal by 113.2 hours (–46.59% against the target), the Slovak Republic of by 9.09 hours (–4.73% against the target), Slovenia by 89.32 hours (–38.34% against the target) and Spain by 1.53 hours (–1.04% against the target).
- 2 A reduction in the number of tax payments in tax administration of Romania by 0.74 points (–5.29% against the target).
- 3 An increase in the rate of CIT returns submitted on time to the tax administrations of Austria by 7.53 points (+9.92% against the target), Belgium by 8.01 points (+9.99% against the target), Bulgaria by 17.91 points (24.35% against the target), Germany by 5.66 points (7.38% against the target), Greece by 3.74 points (3.98% against the target), Hungary by 8.83 points (10.54% against the target), Lithuania by 21,27 points (+34,42% against the target) and the Netherlands by 1.43 points (+1.51% against the target).
- 4 An increase in the rate of PIT returns submitted on time to the tax administrations of Austria by 12,63 points (+16,79% against the target), Belgium by 2,49 points (+2,68% against the target), Bulgaria by 10,71 points (+12,35% against the target), France by 1.27 points (+1.30% against the target), Germany by 10.04 points (+11.61% against the target), Hungary by 8.46 points (+9.28% against the target), Italy by 0.74 points (+0.75% against the target), Lithuania by 10.88 points (+13.24% against the target), Portugal by 2.19 points (+2.24% against the target), Romania by 24.45 points (+33.85% against the target), the Slovak Republic by 18.31 points (+23.95% against the target) and Slovenia by 15.42 points (+18.52% against the target).
- 5 An increase in the percentage of VAT tax returns submitted on time to the tax administrations of Austria by 8.82 points (+11.68% against the target), the Czech Republic by 5.39 points (+5.95% against the target), Greece by 4.35 points (+4.68% against the target), Hungary by 2.67 points (+3.02% against the target), Portugal by 1.17 points (+1.24% against the target) and Slovenia by 3.96 points (+4.68% against the target).

- 6 An increase in the rate of PIT returns with pre-filled income data in the tax administrations of Belgium by 68.1 points, Bulgaria by 100 points, the Czech Republic by 89.53 points, the Netherlands by 17.72 points, Romania by 95.11 points, the Slovak Republic by 83.43 points and Spain by 20.92 points.
- 7 An increase in the cost of investing in IT systems as a percentage of the total operating cost of the tax administration of Austria by 3.09 points, Belgium by 8.45 points, Bulgaria by 13.15 points, the Czech Republic by 7.93 points, France by 11.35 points, Germany by 7.41 points, Greece by 19.91 points, Hungary 22.97 points, Italy by 15.28 points, Lithuania by 3.48 points, the Netherlands by 1.12 points, Portugal by 15.31 points, Romania by 18.55 points, Slovakia by 0.20 points, Slovenia by 18.54 points and Spain by 13.04 points.

Table 14 Tax audits: results of resolution of the CCR (output-oriented) model – relative efficiency

<i>DMU</i>	<i>Score</i>	<i>Rank</i>
Austria	1.00	1
Belgium	0.682	24
Bulgaria	1.00	1
Croatia	0.46	26
Cyprus	1.00	1
Czech Republic	0.65	25
Denmark	1.00	1
Estonia	1.00	1
Finland	1.00	1
France	0.89	21
Germany	1.00	1
Greece	0.85	22
Hungary	1.00	1
Ireland	0.79	23
Italy	1.00	1
Latvia	0.94	20
Lithuania	1.00	1
Malta	1.00	1
Netherlands	1.00	1
Portugal	1.00	1
Romania	1.00	1
Slovak Republic	1.00	1
Slovenia	1.00	1
Spain	1.00	1
Sweden	1.00	1
UK	1.00	1

Table 16 Tax audits: results of resolution of the CCR (output-oriented) model – slacks – targets

DMU	Score	Input 1 (total operating expenditure/total net revenue collected by the tax administration (%))			Input 2 (percentage of staff in enforced debt collections and related functions)			Input 3 (time to comply with a corporate income tax audit (in hours))					
		Actual	Target	Slacks	Differences (%)	Actual	Target	Slacks	Differences (%)	Actual	Target	Slacks	Differences (%)
Austria	1.00	0.83	0.83	0.00	0.00	5.08	5.08	0.00	0.00	2.50	2.50	0.00	0.00
Belgium	0.68	0.91	0.91	0.00	0.00	10.04	10.04	0.00	0.00	5.50	5.50	0.00	0.00
Bulgaria	1.00	1.01	1.01	0.00	0.00	10.02	10.02	0.00	0.00	12.00	12.00	0.00	0.00
Croatia	0.46	0.72	0.72	0.00	0.00	13.12	10.68	2.44	-18.59	36.50	30.97	5.53	-15.16
Cyprus	1.00	1.05	1.05	0.00	0.00	9.06	9.06	0.00	0.00	3.00	3.00	0.00	0.00
Czech Rep.	0.65	1.32	1.07	0.25	-19.06	6.11	6.11	0.00	0.00	2.00	2.00	0.00	0.00
Denmark	1.00	0.52	0.52	0.00	0.00	13.66	13.66	0.00	0.00	4.50	4.50	0.00	0.00
Estonia	1.00	0.33	0.33	0.00	0.00	6.30	6.30	0.00	0.00	1.50	1.50	0.00	0.00
Finland	1.00	0.65	0.65	0.00	0.00	2.70	2.70	0.00	0.00	8.00	8.00	0.00	0.00
France	0.89	0.89	0.69	0.20	-22.30	19.63	16.64	2.99	-15.22	3.50	3.50	0.00	0.00
Germany	1.00	1.37	1.37	0.00	0.00	7.20	7.20	0.00	0.00	4.50	4.50	0.00	0.00
Greece	0.85	0.60	0.60	0.00	0.00	18.00	16.66	1.34	-7.47	3.50	3.50	0.00	0.00
Hungary	1.00	0.54	0.54	0.00	0.00	23.89	23.89	0.00	0.00	4.00	4.00	0.00	0.00
Ireland	0.79	0.54	0.54	0.00	0.00	10.56	5.54	5.02	-47.50	2.00	2.00	0.00	0.00
Italy	1.00	0.84	0.84	0.00	0.00	2.64	2.64	0.00	0.00	5.00	5.00	0.00	0.00
Latvia	0.94	0.81	0.62	0.18	-22.67	7.62	7.62	0.00	0.00	2.50	2.50	0.00	0.00
Lithuania	1.00	0.70	0.70	0.00	0.00	5.98	5.98	0.00	0.00	1.50	1.50	0.00	0.00
Malta	1.00	0.42	0.42	0.00	0.00	6.10	6.10	0.00	0.00	24.50	24.50	0.00	0.00
Netherlands	1.00	0.76	0.76	0.00	0.00	8.17	8.17	0.00	0.00	3.50	3.50	0.00	0.00
Portugal	1.00	1.08	1.08	0.00	0.00	12.58	12.58	0.00	0.00	1.00	1.00	0.00	0.00
Romania	1.00	0.80	0.80	0.00	0.00	19.66	19.66	0.00	0.00	2.00	2.00	0.00	0.00
Slovak Rep.	1.00	1.06	1.06	0.00	0.00	4.08	4.08	0.00	0.00	2.00	2.00	0.00	0.00
Slovenia	1.00	0.67	0.67	0.00	0.00	15.95	15.95	0.00	0.00	29.00	29.00	0.00	0.00
Spain	1.00	0.64	0.64	0.00	0.00	16.77	16.77	0.00	0.00	1.50	1.50	0.00	0.00
Sweden	1.00	0.35	0.35	0.00	0.00	0.00	0.00	0.00	0.00	5.00	5.00	0.00	0.00
UK	1.00	0.67	0.67	0.00	0.00	8.06	8.06	0.00	0.00	6.00	6.00	0.00	0.00

Table 17 Tax audits: results of resolution of the CCR (output-oriented) model – slacks – targets

DMU	Score	Input 4 (percentage of staff in taxpayer's service and ICT)				Output 1 (hit rate of audits (%))			
		Actual	Target	Slacks	Differences (%)	Actual	Target	Slacks	Differences (%)
Austria	1.00	28.80	28.8	0.00	0.00	17.27	17.27	0.00	0.00
Belgium	0.68	37.80	37.8	0.00	0.00	30.24	30.24	0.00	0.00
Bulgaria	1.00	25.98	25.98	0.00	0.00	87.63	87.63	0.00	0.00
Croatia	0.46	54.39	54.39	0.00	0.00	44.58	44.58	0.00	0.00
Cyprus	1.00	22.29	22.29	0.00	0.00	36.78	36.78	0.00	0.00
Czech Rep.	0.65	42.88	42.88	0.00	0.00	25.34	25.34	0.00	0.00
Denmark	1.00	43.08	43.08	0.00	0.00	64.53	64.53	0.00	0.00
Estonia	1.00	42.13	42.13	0.00	0.00	2.25	2.25	0.00	0.00
Finland	1.00	28.23	28.23	0.00	0.00	23.00	23.00	0.00	0.00
France	0.89	33.77	33.77	0.00	0.00	66.65	66.65	0.00	0.00
Germany	1.00	35.20	35.20	0.00	0.00	78.00	78.00	0.00	0.00
Greece	0.85	49.00	49.00	0.00	0.00	64.65	64.65	0.00	0.00
Hungary	1.00	36.60	36.60	0.00	0.00	66.29	66.29	0.00	0.00
Ireland	0.79	44.29	26.34	17.95	-40.52	17.81	17.81	0.00	0.00
Italy	1.00	31.86	31.86	0.00	0.00	82.11	82.11	0.00	0.00
Latvia	0.94	47.82	47.82	0.00	0.00	61.87	61.87	0.00	0.00
Lithuania	1.00	51.51	51.51	0.00	0.00	46.28	46.28	0.00	0.00
Malta	1.00	30.75	30.75	0.00	0.00	59.36	59.36	0.00	0.00
Netherlands	1.00	29.11	29.11	0.00	0.00	50.43	50.43	0.00	0.00
Portugal	1.00	54.99	54.99	0.00	0.00	65.17	65.17	0.00	0.00
Romania	1.00	28.32	28.32	0.00	0.00	51.37	51.37	0.00	0.00
Slovak Rep.	1.00	39.94	39.94	0.00	0.00	32.09	32.09	0.00	0.00
Slovenia	1.00	11.74	11.74	0.00	0.00	8.32	8.32	0.00	0.00
Spain	1.00	36.48	36.48	0.00	0.00	88.77	88.77	0.00	0.00
Sweden	1.00	51.25	51.25	0.00	0.00	70.48	70.48	0.00	0.00
UK	1.00	29.85	29.85	0.00	0.00	62.06	62.06	0.00	0.00

Table 18 Tax audits: results of resolution of the CCR (output-oriented) model – slacks – targets

DMU	Score	Output 2 (training cost/total operating expenditure (%))			Output 3 (percentage of staff allocated to audit, investigation and other verification)				
		Actual	Target	Slacks	Differences (%)	Actual	Target	Slacks	Differences (%)
Austria	1.00	1.14	1.14	0.00	0.00	49.97	49.97	0.00	0.00
Belgium	0.68	0.19	1.02	0.83	435.51	38.91	38.91	0.00	0.00
Bulgaria	1.00	0.42	0.42	0.00	0.00	44.81	44.81	0.00	0.00
Croatia	0.46	0.07	0.09	0.02	35.54	20.54	20.54	0.00	0.00
Cyprus	1.00	0.27	0.27	0.00	0.00	32.60	32.60	0.00	0.00
Czech Rep.	0.65	0.03	0.25	0.22	747.49	20.58	20.58	0.00	0.00
Denmark	1.00	0.00	0.00	0.00	0.00	31.30	31.30	0.00	0.00
Estonia	1.00	0.40	0.40	0.00	0.00	38.66	38.66	0.00	0.00
Finland	1.00	0.31	0.31	0.00	0.00	22.65	22.65	0.00	0.00
France	0.89	1.38	1.38	0.00	0.00	24.29	26.69	2.40	9.88
Germany	1.00	1.39	1.39	0.00	0.00	29.7	29.67	0.00	0.00
Greece	0.85	0.02	1.34	1.32	6621.62	33.00	33.00	0.00	0.00
Hungary	1.00	3.87	3.87	0.00	0.00	39.50	39.50	0.00	0.00
Ireland	0.79	0.70	0.70	0.00	0.00	24.68	24.68	0.00	0.00
Italy	1.00	0.03	0.03	0.00	0.00	36.27	36.27	0.00	0.00
Latvia	0.94	0.23	0.27	0.04	16.55	27.63	27.63	0.00	0.00
Lithuania	1.00	0.29	0.29	0.00	0.00	29.12	29.12	0.00	0.00
Malta	1.00	0.02	0.02	0.00	0.00	21.65	21.65	0.00	0.00
Netherlands	1.00	2.31	2.31	0.00	0.00	37.78	37.78	0.00	0.00
Portugal	1.00	0.20	0.20	0.00	0.00	19.84	19.84	0.00	0.00
Romania	1.00	0.00	0.00	0.00	0.00	31.00	31.00	0.00	0.00
Slovak Rep.	1.00	0.07	0.07	0.00	0.00	22.56	22.56	0.00	0.00
Slovenia	1.00	0.20	0.20	0.00	0.00	57.45	57.45	0.00	0.00
Spain	1.00	0.25	0.25	0.00	0.00	19.51	19.51	0.00	0.00
Sweden	1.00	0.25	0.25	0.00	0.00	36.31	36.31	0.00	0.00
UK	1.00	0.32	0.32	0.00	0.00	39.45	39.45	0.00	0.00

Table 19 Tax audits: results of resolution of the CCR (output-oriented) model – slacks – targets

DMU	Score	Output 4 (ICT cost/total operating expenditure (%))			
		Actual	Target	Slacks	Differences (%)
Austria	1.00	17.17	17.17	0.00	0.00
Belgium	0.68	4.87	12.39	7.53	154.56
Bulgaria	1.00	2.92	2.92	0.00	0.00
Croatia	0.46	16.12	16.12	0.00	0.00
Cyprus	1.00	1.83	1.83	0.00	0.00
Czech Rep.	0.65	8.06	8.06	0.00	0.00
Denmark	1.00	24.10	24.10	0.00	0.00
Estonia	1.00	0.35	0.35	0.00	0.00
Finland	1.00	24.16	24.16	0.00	0.00
France	0.89	5.07	5.07	0.00	0.00
Germany	1.00	6.21	6.21	0.00	0.00
Greece	0.85	0.27	5.99	5.72	2,119.33
Hungary	1.00	0.00	0.00	0.00	0.00
Ireland	0.79	9.40	9.40	0.00	0.00
Italy	1.00	5.52	5.52	0.00	0.00
Latvia	0.94	9.61	9.61	0.00	0.00
Lithuania	1.00	6.64	6.64	0.00	0.00
Malta	1.00	27.52	27.52	0.00	0.00
Netherlands	1.00	17.67	17.67	0.00	0.00
Portugal	1.00	5.60	5.60	0.00	0.00
Romania	1.00	0.00	0.00	0.00	0.00
Slovak Rep.	1.00	13.53	13.53	0.00	0.00
Slovenia	1.00	2.48	2.48	0.00	0.00
Spain	1.00	5.17	5.17	0.00	0.00
Sweden	1.00	20.55	20.55	0.00	0.00
UK	1.00	16.08	16.08	0.00	0.00

5.4 *Measuring of the efficiency of tax administrations with regard to the tax audits*

The application of the basic CCR DEA model (output oriented), with regard to the efficiency of tax administrations under investigation, in the field of tax audits (Table 14), showed that 19 tax administrations are fully efficient, which indicates that the majority of tax services under consideration (more than 73%) converts inputs into outputs in such a way as to achieve the largest possible amount of outputs, making use of the smallest possible amount of inputs and in fact at the lowest cost. In other words, they operate at 100% of their efficiency, so that none of the outputs can increase without increasing other input (or inputs) or reducing other output (or outputs). In particular, the analysis showed that the tax administrations of Austria, Bulgaria, Cyprus, Denmark, Estonia, Finland,

Germany, Hungary, Italy, Lithuania, Malta, the Netherlands, Portugal, Romania, the Slovak Republic, Slovenia, Spain, Sweden and the UK are fully efficient, allocating its resources in such a way that the results of their tax audits are considered satisfactory. The lowest efficiency is presented by the tax administration of Croatia (45.80%) in contrast to the tax administration of Latvia, which shows a high degree of efficiency (94%), without, however, being fully efficient. The average efficiency of the tax administrations of the 26 European countries is estimated at 93.33%.

The examination of the reference set (Table 15) shows that the tax administrations of Sweden and Spain are the most decisive efficient units for the formation of the efficiency frontier, as they appear as reference units in many inefficient tax administrations. Furthermore, the tax administrations of Cyprus, Germany, Finland and Romania appear to be fully efficient but are not a reference unit for any inefficient tax administration, so they are not in fact fully efficient units.

In addition, with regard to the additional improvement (slacks) that can be achieved on inefficient units in the form of an increase in outputs and/or a decrease in inputs to make them efficient, the development of the DEA model has shown (see Tables 16, 17, 18 and 19) that it is necessary:

- 1 A reduction in the total operating costs as a percentage of the total net revenue collected by the tax administration of the Czech Republic by 0.25 points (−19.06% against the target), France by 0.19 points (−22.30% against the target) and Latvia by 0.18 points (−22.67% against the target).
- 2 A reduction in the percentage of staff allocated to debt collection procedures and related functions in tax administrations of Croatia by 2.44 points (−18.59% against the target), France by 2.99 points (−15.22% against the target), Greece by 1.34 points (−7.47% against the target) and Ireland by 5.02% (−47.50% against the target)
- 3 A reduction of the time required to correct an error in the CIT return and, if there is a possibility of an audit by the tax authority, more than 25%, of the time required to prepare and submit audit data and information (Time to comply with a corporate income tax audit) to the Croatian tax administration by 5.53 hours to be reduced from 36.5 hours to 30.96 hours.
- 4 A reduction in the percentage of staff allocated to serving taxpayers and providing computer IT services to the tax administration of Ireland by 17.95 points (−40.92% against the target).
- 5 An increase in staff training costs as a percentage of the total operating costs of the tax administration of Belgium by 0.83 points, Croatia by 0.025 points, the Czech Republic by 0.22 points, Greece by 1.32 points and Latvia by 0.038 points.
- 6 An increase in the percentage of staff available for audit, investigation and other verifications in the French tax administration by 2.4 points (+9.88% against the target) and
- 7 An increase in the cost of investing in IT systems as a percentage of the total operating costs of the tax administration of Belgium by 7.53 points and Greece by 5.72 points.

6 Conclusions and policy implications

The level of tax compliance is a critical factor in improving a country's macroeconomic balance and at the same time a major threat to its sustainable development. In this sense, the efficiency of the tax administration is one of the most important priorities of an economy, as the level of tax revenue collected by the tax authorities, significantly determines the economic policy of a country both in terms of public investment and supply of public goods, as well as at the stage of shaping the social and redistributive policy. Therefore, the creation of an appropriate mechanism for monitoring and evaluating the efficiency of the tax administration in its various areas of action, is a useful tool to improve the level of tax revenue and increase tax compliance. In this paper, an attempt was made to evaluate the efficiency of the tax administrations of 26 European countries in the areas of taxpayer service, collection of public revenues, strengthening voluntary compliance and conducting targeted tax audits, the results of which showed useful conclusions regarding the improvement of revenue collection structures and the reform actions to be taken by the tax administrations, which include strategies for promoting information systems upgrading programs so that they can successfully respond to the collection and analysis of financial and other large-scale taxpayers' data, implementation of compliance programs based on risk analysis criteria and the formation of a taxpayer-oriented operating framework. At the same time, improving the level of electronic communication with taxpayers, in the form of extending the electronic methods of filing tax returns and generally increased digitisation procedures, will lead to a reduction in compliance time, a higher level of tax collection, a lower level of tax evasion and increased efficiency of tax administrations.

The contribution of the study is summarised in the analysis and discussion of conceptual and methodological issues related to the measurement of the efficiency of tax administrations and the analysis of the results that reveal the extent to which exogenous non-discretionary factors influence tax administrations' ineffectiveness. The main result was the classification of tax administrations in the areas examined, the assessment of the degree of relative efficiency and the identification of the efficient tax services which could serve as a benchmark of best practice for the inefficient ones. Furthermore, the analysis showed that the average efficiency of European countries' tax administrations is high, as levels of relative efficiency were recorded, above 80% in all the areas examined (90.15% taxpayers' service, 81.63% tax revenue collection, 88.52% enhancement voluntary compliance and 93.33% targeted tax audits), and were observed a large number of tax administrations operating at the appropriate scale. In addition, the management of the human resources and technological infrastructure are seen as factors that significantly influence the efficiency of tax administration and require improvement in many cases, by investing in new information systems and hiring specialised IT staff. Similarly, there is a need to increase the level of tax return filing using electronic methods, mainly for individuals, and to strengthen the effort to create databases with third party information and pre-filled tax returns, as the results indicate that these activities will improve the efficiency of tax administration, mainly by reducing the level of tax evasion, and this finding is in line with the conclusions of Dragojlovic et al. (2014) and Jensen and Wöhlbier (2012). In addition, although the level of tax revenue collected by European tax administrations is satisfactory (since no significant improvement needs are recorded), there is considerable room for improvement in the level of arrears, which indicate the need to reduce the large amount of taxpayers' arrears that has accumulated during the

financial crisis of the previous decade. In the area of tax compliance enhancement, the results showed that is required an increase in the level of tax returns submitted on time, mainly in the taxation of individuals and legal entities (CIT and PIT) and less in VAT. where the corresponding improvement rate appears lower and in a few cases. With regard to the tax audits carried out by the European tax administrations, the results of the analysis showed that the success rates are satisfactory without need of further improvement, indicating the conduct of targeted audits that lead to the disclosure of undeclared income, mainly through the application of risk analysis methods and continuous information cross-checking with third parties. With regard to the use of the resources available to European tax administrations, it is found that the allocation of staff in the areas of tax audits and enforcement debt collection is effective, while there is a need to increase the number of staff employed in the service of taxpayers and, especially in the use of information systems. At the same time, there are significant margins for improving the level of operating costs in relation to the revenues collected in many tax administrations, at levels of reduction up to 48%. Finally, factors related to the number of payments and compliance time appear to influence the effectiveness at the level of voluntary compliance, and this is in line with the theory (Reeson and Dunstall, 2009; Alm et al., 2010).

From a policy perspective, we should be particularly careful in drawing conclusions about the policy/management impact of the research, as any application of quantitative analysis to decision-making is constrained, especially when dealing with complex problems such as the issue of the assessment of the efficiency of tax services (Katharaki and Tsakas, 2010). In this study the DEA analysis tend to approach the issue at hand through the definition of general principles as dictated by conventional policy. The emerging data were used to shed light on “best practice tax administrations” used as reference for comparison purposes. In any case and in spite of the reservations that one could articulate, the resulting body of data helps define key activities and fundamental principles that should be adopted by those tax administrations shown to operate below the optimal level. The results therefore highlight the need for measures to be taken in relation to human resources management, particularly in the IT sector and the use of advanced technological infrastructure, while the creation of databases with third party information and the expansion of electronic submission of tax returns appear to contribute positively to the efficiency of tax services.

However, the empirical study suggests that future research could focus on dynamic factors based on the specific characteristics of each country that influence the efficiency of tax administration, such as economic factors depending on whether the economy is characterised as rural, industrial, commercial or tourist and other socioeconomic factors. A possible direction for further research is also the application of the Malmquist productivity index (Sigbjørn et al., 1991; Bjurek and Hjalmarsson, 1995; Odeck, 2005), as well as the combination of available techniques such as the bootstrap (Simar and Wilson, 2007) in the investigation of tax administrations efficiency over a time period. Despite the limitations related to the data set, the empirical work here suggests that future research may need to concentrate on the dynamic factors, i.e., characteristics of the regional where the tax administration is situated or even the level of economic development which could play a significant role in a tax administration performance.

The general conclusion is that a governance framework within the tax administrations, intending to improve organisational efficiency, is needed. Similar conclusions are also drawn by Barros (2007) and Katharaki and Tsakas (2010), who

highlighted the need of an organisational government environment, with accountability, transparency and efficiency incentives which explicitly oblige the tax administrations to achieve efficiency in their operational activities. The establishment of a transparent accessible data set (including data related to contextual factors beyond managerial control) at European level should be introduced and a benchmark analysis should be carried out in order to policy and decision makers know exactly which tax administrations utilise inefficiently the allocated resources and the magnitude of the changes need to be undertaken. We need to be aware that the implementation of these reform proposals, as discussed in detail in the individual sections of the study, is a long-term process that requires difficult decisions by tax administrations. However, this is the right way to create a modern and efficient tax administration, able to meet the requirements of the modern era and deal with complex tax issues.

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