

Modeling the detecting process of tax evasion

Abstract. In contrast to the classical approaches of the standard model of tax evasion based on game theory, our manuscript has considered the detection of tax evasion as one of the main function of tax administration and has proposed a model for assessing the probability of tax evasion. This investigation has been carried out on the basis of research methods such as scientific abstraction and systematic analysis, expert evaluation, logical generalization, statistical analysis. The level of tax administration, as well as the probability of detection of tax evasion in the Republic of Azerbaijan has been assessed with the proposed model and depend on the results, recommendations have been consulted for improving appropriate tax system. Proposed model drives practical significance as a providing effective activity of tax institutions by defining the level of tax administration, as well as, as an impacting remarkably the revenue of state budget by determining the probability of tax evasion's detection.

Keywords. Probability of detection of tax evasion, tax administration efficiency index, Allingham-Sandmo model, expert evaluation.

1. Introduction

Tax evasion is an illegal activity in which an economic entity deliberately evades paying a real tax liability, and by its nature is an extremely difficult process to observe. Many literatures distinguish two forms of tax evasion: tax evasion and tax avoidance. While tax avoidance occurs due to loopholes in tax legislation, tax evasion occurs as a result of violation of tax legislation. Tax avoidance is a different declaration of economic activity to the tax authority in order to reduce the real tax liability, however tax evasion characterizes all illegal activities involving the hidden or shadow economy, unmeasured economic activity (online trade and etc.).

Therefore, they cannot be confused to each other. Since this global problem is widespread all around the world and could not be eliminated yet, its theoretical and practical research has been one of the main interests of economists and politicians for many years. For this reason, a wide range of research and assessment mechanisms exist on reducing the level of tax evasion, its origin, its detection and other similar issues. Let's look through some research on tax evasion.

2. Related literature

Thomas M. Porcano's study was one of the researches that to reduce the level of tax evasion in the period of increasing tax evasion in the United States. In his study, he analyzed the impact of 18 variables that could affect tax evasion. Special attention was paid to the use of these variables as independent variables in discriminant analysis to determine their relationship with tax evasion. However, the results showed that these variables affected distinctly to the different types of tax evasion and that not all variables significantly affected tax evasion (Porcano 1988). Using rich administrative information and convex political changes, investigating and enforcing the shift between illegal tax evasion and legal tax avoidance forced some wealthy people in Norway to disclose their previously hidden assets abroad. From the moment they were revealed, increasing of the taxes paid by these individuals by 30% and that continuing of growth was observed over time. The results of the study showed that the detection of tax evasion by some wealthy people could be an effective way to increase tax revenues and reduce inequality in the country (Alstadsæter et al. 2018). Charles T. Clotfelter explored the relationship between marginal tax rates and tax evasion. The data used in the study consisted of observations of the actual tax return information of individuals obtained as a result of a request from the Internal Revenue Service's Taxpayer Compliance Measurement Program (TCMP) for 1969. Overall, the results showed that excessive tax rates had a significant effect on the amount of tax evasion (Clotfelter 1983). Tanzi, who tried to explain illegal activities in his research using aggregate information, had investigated the shadow economy in the United States. He

proposed an econometric model that took into account the ratio of foreign currency deposits to the money supply as an indicator of hidden transactions - interest rates, the distribution of wages and salaries in personal income, per capita income and the average tax rate (Tanzi 1980). The impact of the tax rate on tax evasion in China was investigated by examining the relationship between the tariff schedule and the "evasion gap" by determining the difference between Hong Kong's declared level of exports to China and China's declaration of goods imported from Hong Kong. As a result, a one percent increase in the tax rate was revealed a 3 percent increase in tax evasion (Fisman, and Wei 2004). An empirical analysis of income tax discrepancy was conducted in Switzerland based on a standard model of tax evasion. Modification of that model revealed that the incompleteness was positively correlated with inflation. As a result, the discrepancy is significantly lower when there is direct control over citizens or taxpayers, and in contrast when there is no control (Pommerehne and WeckHannemann 1996).

As numerous theoretical and empirical analyses exist related with the tax evasion, it is feasible to expand further the review of the literature.

2.1. Evaluation models for detecting tax evasion

When have a look the literature, we have observed that several specific assessment models have been used to detect tax evasion. One of the first and most widely used models for assessing tax compliance was proposed by Allingham M., Sandmo A. The classic model of rational choice of the taxpayer was based on the assumption that the taxpayer's decision to evade tax depends on the tax rate, the probability of detection of tax evasion and the rate of penalties. At the same time, this model assumed that in the circumstances of uncertainty the compliance of taxpayer's behaviors with the axioms of the Von Neumann-Morgenstern utility function and determined the expected utility of the income according to the reporting decision. The general expression of this model is as follows:

$$E[U] = (1 - p)U(W - \theta X) + pU(W - \theta X - \pi(W - X)) \quad (1)$$

Where, W – is the real income of the taxpayer that unknown to the tax authority; X – declared income; θ – tax rate; p – the probability of detection of tax evasion and was assumed to be exogenous for the individual taxpayer in the model under consideration; π – penalty imposed when hidden income ($W - X$) is discovered; $E[U]$ – indicates the maximum utility of the taxpayer (Allingham and Sandmo 1972).

This model has been accepted by many scholars as a standard model of tax evasion and various modifications have been developed to take into account the changing tax system, socio-economic situation, taxpayers and other factors. As an example, let us consider a few of them:

In Lectures on Public Finance book chapter, the taxpayer's max utility function was defined by equation (1) and the probability of tax evasion was determined due to the penalty rate to be applied (Hindriks and Myles 2014). Theoretical and empirical analysis of the model of the first application of game theory to tax evasion was studied by James Andreoni and his co-authors, its shortcomings were identified and suggestions for the development of the model were made (Andreoni et al. 1998). Modifications with the addition of labor force to the generalization of the simple Allingham-Sandmo model include studies by Sandmo (1981), Cowell (1981), Pencavel (1979), Weiss (1976), and others. One of the extended modifications of the standard model belongs to John H. Pencavel. He developed three modifications of the standard model and examined the robustness of these results. The first modification involved the assumption of a simplification of linear income tax schedules, the second involved considering an alternative form of the existing penalty function in the model, and the third surrounded the considering the consequences of a taxpayer's decision to declare joint hourly earnings (Pencavel 1979). According to Laurence Weiss 'Fraudulent tendencies encourage individuals to work harder to insure themselves against penalties that may arise from audits, which in turn can lead to increased fraud' (Weiss 1976). Another modification of the Allingham-Sandmo model is to take into account the iteration nature of the

reporting decision. One of the very few studies examining the dynamics of tax compliance belongs to Engel and Hines (1990). In their study, a model was proposed that influenced the response of individual and collective tax evasion to changes in the economic environment.

3. Detection of tax evasion as a main function of tax administration

Two important results are claimed in the existing literature on income tax evasion:

1. Higher tax rates result to pay more taxes by declaration,
2. An increase in gross income causes a decrease in its declared part of it.

In general, most investigations related with tax evasion, its detection and etc. have been conducted on income taxes or fines. In the existing analyzes the probability of the detection of tax evasion are accepted as either an exogenous variable or the edges of it are identified by related with the penalty that occurs in case of detection. Actually, no specific assessment of the probability of detection of tax evasion has been made. Therefore, this study attempts to measure the probability of tax evasion's detection through the efficiency of tax administration, which is one of the main function of tax administration. For this purpose, we have proposed a special model for the efficiency of tax administration, on this base of which the index of efficiency of tax administration has been determined and appropriate calculations have been made.

For this, in the first stage, tax administration and its functions have considered. Taking into account its impact on economic development and the formation of the state budget, we can mention that the improvement of tax administration is one of the most crucial conditions for the effective organization of public policy. Therefore, the main tasks of the tax administration, their improving by investigated each of them separately, is one of the essential issues facing the state.

The main functions of tax administration are below (Alink and Kommer 2016):

- registration of taxpayers, including detection of non-registration and false registration;

- processing of tax returns, withholdings and third-party information;
- verification or examination of the correctness and completeness of received information (including audit activities);
- assessment of taxes due;
- process of enforced debt collection;
- handling of administrative appeals and complaints;
- provision of service and assistance to taxpayers;
- detection and prosecution of tax fraud; and
- imposing of penalties and interest payments.

When looking through the functions of tax administration, we observe that its main purposes are to involve taxpayers to the paying taxes in the manner prescribed by law, and to prevent tax evasion, fraud. In this sense, providing of effective activity of tax administration primarily leads to a reduction of tax evasion or detection of these types of circumstances, in other words, higher level of tax administration in the country can cause to less cases of tax evasion or avoidance. The reduction of tax evasion may occur by public awareness, severe financial sanctions, the applying of fines, the professionalism of tax administrators and other administrative measures. In this sense, by measuring the effectiveness of tax administration, we can determine the probability (p) of detection of tax evasion, avoidance or other similar frauds.

4. Modeling the process of assessing the probability (p) of detection of tax evasion

4.1. Defining the effectiveness indicators of tax administration

The choice of factors used in tax administration efficiency studies is based solely on the assumption of internal system factors may affect efficiency. However, international experience and our observations show that the importance of external micro and external macro environmental factors is not less, but more essential. Therefore, a systematic approach must be used for assessing the effectiveness of tax

administration by using a system of 3 groups of factors that reflect third the internal environment and the external microenvironment and the external macroenvironment. In this purpose, let's accept the following notation for making a mathematical model:

i –the groups of factors;

j – factors that included in groups;

m –the number of groups;

n_i – the number of factors that in group i ;

x_{ij} – represents the j factor of i group.

In this case, the matrix of factors (X) that affecting the efficiency of tax administration is as follows:

$$X = (x_{ij}) \quad i = \overline{1,3}, j = \overline{1,n_3} \quad (2)$$

Or

$$X = \begin{pmatrix} x_{11} & x_{12} & \dots & x_{1n_1} \\ x_{21} & x_{22} & \dots & x_{2n_2} \\ x_{31} & x_{32} & \dots & x_{3n_3} \end{pmatrix}$$

By assessing the levels of these 3 groups of indicators in the tax administration under investigation, problems such as revealing the factors that negatively affect its activity, improving them depending on their importance or not taking them into account at all can be solved.

In this purpose, in this manuscript, initially, the level of the proposed indicators that characterizing the activity of tax administration is assessed by the expert survey method. Then, the appropriateness of the expert assessments is checked using the Kendall coefficient. The next step is to propose a tax administration effectiveness index using reliable information obtained.

4.2. Expert assessment and Kendall coefficient

Decision-making is the main process that organizes the daily activities of any field, even each individuals. Therefore, relying on a trustworthy source (in any field) in the decision-making process is one of the crucial principles of administration. Methods and tools based on the knowledge and skills of experts are helpful in situations of uncertainty, such as lack of information, unreliability and others that can be impacted seriously negative on decision-making. Necessary and, most importantly, reliable information is obtained using expert decision-making methods (voting, survey, Delphi, etc.) that allow to give opportunity for realising assessments in the area under study. For this purpose, an expert quiry method is used to determine the impact of selected efficiency indicators on tax administration.

Assume that the level of efficiency indicators of tax administration identified in 3 groups $n_i, i = \overline{1,3}$ are assessed by a number of f experts. It is envisaged that f_1 percent of these experts would be tax specialists, f_2 percent would be taxpayers and f_3 percent would be economist-politician scientists, researchers.

Where, $f_1 + f_2 + f_3 = f = 100\%$

In general, the responds of the experts can be expressed as follows:

$$v_{ij}^k, \quad i = \overline{1,3}, j = \overline{1,n_3}, k = \overline{1,f} \quad (3)$$

Where, k – are the experts who participate in the survey, v_{ij}^k – express the values of experts that are given for each $x_{ij}, i = \overline{1,3}, j = \overline{1,n_3}$ factors. They can be obviously as below:

$i = 1, j = n_1$ experts values of first group factors

$$\begin{pmatrix} x_{11} \\ x_{12} \\ \vdots \\ x_{1n_1} \end{pmatrix} \sim \begin{pmatrix} v_{11}^1 & v_{11}^2 & \dots & v_{11}^f \\ v_{12}^1 & v_{12}^2 & \dots & v_{12}^f \\ \vdots & \vdots & \dots & \vdots \\ v_{1n_1}^1 & v_{1n_1}^2 & \dots & v_{1n_1}^f \end{pmatrix}$$

$i = 2, j = n_2$ experts values of second group factors

$$\begin{pmatrix} x_{21} \\ x_{22} \\ \vdots \\ x_{2n_2} \end{pmatrix} \sim \begin{pmatrix} v_{21}^1 & v_{21}^2 & \dots & v_{21}^f \\ v_{22}^1 & v_{22}^2 & \dots & v_{22}^f \\ \vdots & \vdots & \dots & \vdots \\ v_{2n_2}^1 & v_{2n_2}^2 & \dots & v_{2n_2}^f \end{pmatrix}$$

$i = 3, j = n_3$ experts values of third group factors

$$\begin{pmatrix} x_{31} \\ x_{32} \\ \vdots \\ x_{3n_3} \end{pmatrix} \sim \begin{pmatrix} v_{31}^1 & v_{31}^2 & \dots & v_{31}^f \\ v_{32}^1 & v_{32}^2 & \dots & v_{32}^f \\ \vdots & \vdots & \dots & \vdots \\ v_{3n_3}^1 & v_{3n_3}^2 & \dots & v_{3n_3}^f \end{pmatrix}$$

For an objective analysis of the obtained information during the expert assessment, the consistency of the responds should be examined. Using the Kendall coefficient (1939), we can determine the appropriateness of the individual experts' assessments based on their experience, knowledge and skills, that characterize the impact of the factors which have been determined by us, on tax administration. In this case, the Kendall coefficient is calculated by the following formula:

$$W_i = \frac{12 * S_i}{f^2 * (n_i^3 - n_i)}, \quad i = \overline{1,3} \quad (4)$$

Where, W – is Kendall concordance coefficient;

S – is the sum of squared deviations and depends on our variables is defined as follows:

$$\text{For } n_1: \quad \overline{v}_1 = \frac{\sum_{j=1}^{n_1} (\sum_{k=1}^f v_{1j}^k)}{f} \quad (\text{the mean})$$

$$S_1 = (\sum_{k=1}^f v_{1j}^k - \overline{v}_1)^2, \quad j = \overline{1, n_1} \quad (5)$$

$$\text{For } n_2: \quad \overline{v}_2 = \frac{\sum_{j=1}^{n_2} (\sum_{k=1}^f v_{2j}^k)}{f}$$

$$S_2 = (\sum_{k=1}^f v_{2j}^k - \overline{v_2})^2, \quad j = \overline{1, n_2} \quad (6)$$

$$\text{For } n_3: \quad \overline{v_3} = \frac{\sum_{j=1}^{n_3} (\sum_{k=1}^f v_{3j}^k)}{f}$$

$$S_3 = (\sum_{k=1}^f v_{3j}^k - \overline{v_3})^2, \quad j = \overline{1, n_3} \quad (7)$$

f – the number of experts;

$n_i, i = \overline{1, 3}$ – is the number of evaluated factors.

The data obtained by confirming the objectivity of the expert assessments using the Kendall concordance coefficient, can be taken into account in the evaluation of the tax administration efficiency index. Since the condition $0 \leq W \leq 1$ is satisfied, the coefficients 0 and 1 indicate in accordance with there is no correspondence between the estimates of the survey participants and are completely consistent. Interior states in $[0,1]$ indicate that the appropriateness is strong as it approaches to 1.

4.3. Effectiveness index of tax administration

The following formulation is proposed for the tax administration efficiency index:

$$I = \frac{\sum_{i=1}^3 I_i}{r_t} \quad (8)$$

Where, I – the effectiveness index of tax administration;

r_t – the rank of the under investigated country for tax liability*;

Note*: A new evaluation methodology can be developed as a result of special research for this parameter or existing international assessments can be used.

Taking into account the above, we can estimate the probability of detection of tax evasion by the formula obtained by using the indicators characterizing the activity of the tax administration: In this case, for p:

$$p = I = \frac{\sum_{i=1}^3 I_i}{r_t} \quad (9)$$

Equation can be written.

I_i – is a parameter that characterizes the impact of all 3 groups of factors on tax administration, determined by the internal environment, external microenvironment and external macroenvironment, using expert assessments for the country under study. And accordingly for each of the 3 groups is calculated as follows:

$$I_1 = \sqrt[n_1]{\prod_{j=1}^{n_1} \left(\frac{\sum_{k=1}^f v_{1j}^k}{f} \right)} \quad (10)$$

$$I_2 = \sqrt[n_2]{\prod_{j=1}^{n_2} \left(\frac{\sum_{k=1}^f v_{2j}^k}{f} \right)} \quad (11)$$

$$I_3 = \sqrt[n_3]{\prod_{j=1}^{n_3} \left(\frac{\sum_{k=1}^f v_{3j}^k}{f} \right)} \quad (12)$$

Considering the (10), (11) and (12) expressions in (9), we obtain the following equation:

$$p = I = \frac{\sum_{i=1}^3 I_i}{r_t} = \frac{\sqrt[n_1]{\prod_{j=1}^{n_1} \left(\frac{\sum_{k=1}^f v_{1j}^k}{f} \right)} + \sqrt[n_2]{\prod_{j=1}^{n_2} \left(\frac{\sum_{k=1}^f v_{2j}^k}{f} \right)} + \sqrt[n_3]{\prod_{j=1}^{n_3} \left(\frac{\sum_{k=1}^f v_{3j}^k}{f} \right)}}{r_t} \quad (13)$$

5. Calculation on the proposed model

In order to check the adequacy of the proposed model to the process under investigation, the assessment of the administrative efficiency index for the tax system of the Republic of Azerbaijan has been carried out by a small group including 10 experts by taking into account above-mentioned percentage. As mentioned, the indicators characterizing the activity of the tax administration are defined in three

groups: internal environment, external micro environment and external macro environment, and each of them consists of the following sub-set:

1. Internal environmental factors:

- Professionalism level of tax officials;
- Digitalization level of the tax authority;
- Forecasting of tax potential and collection level;
- Level of mandatory tax collection;
- Level of additional calculations;
- The level of clarity and reliability of the legal framework;
- Measures to increase the efficiency of human resources (awards, trainings and etc.);
- Level of service.

2. External micro environmental factors:

- Tax literacy of the citizens;
- Level of business awareness;
- Dependence level of business on tax legislation;
- Compliance level of business to the tax liability;
- The tendency of business to tax evasion;
- Digitalization level of business;
- Digitalization level of the bank credit system;
- Number of taxpayers' complaints.

3. External macro environmental factors:

- The income level of the population;
- Digitalization level of the economy;
- Propensity level of the population to business (specific weight of state business, specific weight of population);
- The level of the shadow economy.

In this case, the indicators included in the i th group that mentioned in equation (2) will be $n_1 = 8, n_2 = 8, n_3 = 4$. In order to assess the level of these factors

characterizing the activity of tax administration, in Azerbaijan tax system, have been consulted with 10 experts, including 4 taxpayers, 4 tax specialists, and 2 economic-political scientists. Their estimates due to each factor involve range of [0-10].

As remarked in the methodology of assessing the efficiency index of tax administration, the objectivity of the experts' responds is the crucial condition, and the Kendall coefficient has been used to verify it. Since the set of indicators is systematized in 3 groups, the correspondence of the expert opinions calculated separately for each of the Kendall coefficients (4), in other words, the usefulness of them for calculating index has been checked. Based on calculations:

$$S_1 = 2273,8; W_1 = 0,541$$

$$S_2 = 3402,8; W_2 = 0,810$$

$$S_3 = 2171; W_3 = 0,516$$

Since the score of W test is equal between [0,1], the coefficients 0 and 1 indicate that there is no correspondence between the assessments of the survey participants and are completely consistent, respectively. According to our calculations, the results of the Kendall compliance ratio show that there is a significant correlation between the values of the second group of indicators. However, all 3 results also confirm that the expert assessments are objective and can be used in the calculations for their intended purpose. As an example, this correspondence can be observed in the following diagram of the assessments of 8 internal environmental indicators by 10 experts:

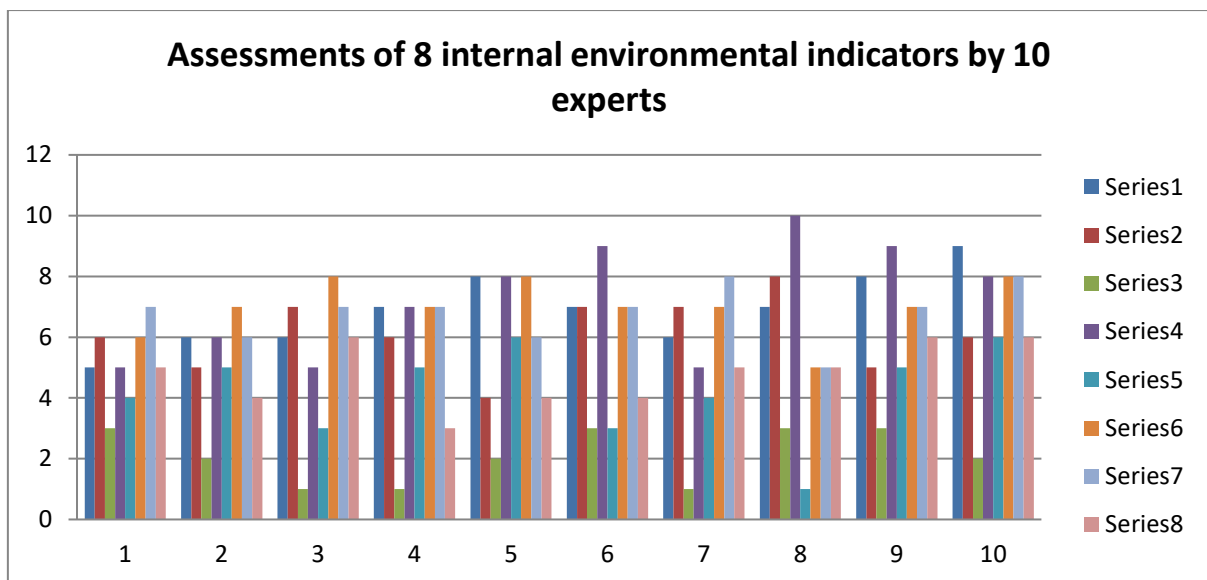


Fig 1. Evaluation diagram of 8 (internal) factors by 10 experts

In the next step, let's calculate the efficiency index by using the equation (13):

$$I_1 = 5.28, I_2 = 5.4, I_3 = 5.63;$$

$r_t = 28$, It should be mentioned that the ranking of Azerbaijan in the World Bank's assessment according to taxation, has been used in these calculations.

In this case, $p = I = 0,58$.

Conclusion

The study substantiated that detection of tax evasion is the main function of tax administration, the probability of detection of tax evasion can be assessed by organizing effective administrative activities, and a model has been proposed for this purpose. The proposed model has been tested on the example of the Azerbaijani tax administration with the help of a small group of experts, and as a consequence, by determining the level of administration, the probability of detection of tax evasion has been assessed. The results show that the process of detecting tax evasion, as well as tax administration in the tax system of Azerbaijan, accordingly, needs to be improved. For increasing of the detection level of tax evasion, tax administration process should be reconsidered, such as :

- Reinvestigating of the indicators system that characterizing the activity of tax administration, and impacts of them;
- Defining the factors that affect efficiency negatively and development of new methodologies different from the existing assessment for improving these factors

And other such measures may have a positive effect.

It needs to be mentioned especially, the level of tax administration, as well as the probability of tax evasion's detection in other countries also, can be assessed by forming an appropriate database for other countries using our methodology.

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