Original Research

Analysis of the Tax Gap and Its Affecting Factors Using Game Theory Approach

Mohammad Hadi Sobhanian(iD)
Department of Management, Kharazmi University, Tehran, Iran

Salah Salimian[1](iD)
Department of Economics, Urmia University, Urmia, Iran

Azadeh Ashrafi(iD)
Department of Public Administration, Faculty of Management and Social Sciences, North Tehran Branch, Islamic Azad University, Tehran, Iran

Abstract

The tax gap can be considered as the criterion and principle of the effectiveness and efficiency of the tax system. Inadequate collection of taxes as well as non-realization of tax revenues is called tax gap, which is one of the factors that aggravate the budget deficit. In this paper, the issue of tax gap is investigated with two approaches. The first approach is a situation where two groups of investigators who are willing and unwilling to collude with two groups of taxpayers who are willing and unwilling to collude with a uniform distribution are placed in the game. The second approach also shows a situation where the probability of not discovering a taxpayer's violation is shown by a mathematical function and the quality of investigating groups for taxpayers who are uniformly distributed is unknown. The results of the first approach show that with the increase in the number of taxpayers unwilling to collude and the increase in the number of groups willing to collude with taxpayers, the tax gap decreases. Also, with the reduction of the tax rate and the increase in the number of groups unwilling to collude, the tax gap increases. The results of the second approach show that the tax gap increases with the increase in the number of investigators and also the increase in the probability of dishonesty of the taxpayer.

Keywords: Game Theory, Tax Gap, Taxpayers, Uniform Distribution.

JEL Classification: C70, E25, H21

[1] *Corresponding author's Email: salahsalimian@yahoo.com*

Introduction

One of the main financial sources of governments is tax, and in many countries of the world, the main planning in the field of employment, security, price stabilization, etc. is done based on it. In recent years, the necessity of identifying effective obstacles in the process of tax collection and empowering the tax system due to the change in the approach of governments' revenue sources towards taxes is undeniable (Salimian et al., 2023). This applies not only to developing countries, but also developed countries are always trying to make the tax system more efficient (Le et al., 2012). Since there is usually a difference between declared and diagnostic tax due to some reasons, this causes in addition to the dissatisfaction of taxpayers, the tax process will be prolonged and will bring a lot of costs to the tax affairs organization (Pakdaman et al., 2014).

The tax gap is defined as the difference between the tax collected and what should be collected according to the laws, and includes things such as tax evasion and deferred taxes, etc. The main factor in the tax gap can be called the inefficiency of the tax system, and if the government's tax revenues are not realized, then, in order to compensate for its budget deficit, the government will turn to printing banknotes and borrowing from the central bank, both of which will cause severe inflation and eventually inefficiency and paralysis of the economy (Khandani & Sameti, 2016).

Governments usually rely on tax declarations prepared by taxpayers (which are usually different from the original and diagnostic tax) and submitted to the tax affairs organization, and this, due to the lack of necessary efficiency in the tax process and the lack of transparency of taxpayers' information, will cause the rights of the beneficiaries to be violated (Didar et al., 2013). A look at this important revenue source for countries reveals that the greater the share of taxes in government expenditures, the more it remarkably prevents the occurrence of undesirable economic effects (Khalilzadeh Silabi et al., 2022). Tax avoidance is in fact the use of gaps and weaknesses of the tax system to reduce tax without violating the laws and regulations. It should be noted that the focus of this paper is on tax avoidance. Tax planning strategies which utilize complex group structures to reduce a company's tax burden without violating tax laws may be morally reprehensible or highly questionable, as these methods are not illegal) Wilson, 2009; Lisowsky, 2010).

Tax evasion and tax avoidance are the main challenges and fundamental obstacles in the tax collection process in most countries. Tax evasion includes non-realistic financial tax reporting such as falsified income, profits, or profits less than the actual amount owed (Becker, 1974).

Tax avoidance; legally using tax laws and the tax system to one's advantage in order to reduce the amount of tax owed (Scott et al., 2010). It is important to note

that both tax evasion and tax avoidance can be considered as forms of tax disability (Wenzel, 2002). Concerning the above definitions, one should distinguish tax evasion and tax avoidance. Tax avoidance is any legal method used by a taxpayer to minimize the amount of income tax owed or in fact to get around the law. In other words, tax avoidance is to take benefit of tax system of the country to reduce the tax owned (Dyreng et al., 2008). Investigating and measuring each of the factors that create the tax gap and the inefficiency of the system tax is very important. Finally, it should be mentioned that since the tax gap is one of the main factors affecting the budget deficit, therefore the factors affecting the tax gap can bring a country's economy into crisis, because when the government faces increasing deficits it is possible to print banknotes and borrow from the central bank. These cases have increased the amount of liquidity in the country it will cause severe inflation and break the reins, which will paralyze the economy of a country.

In Table 1., a number of studies conducted in the field of the research topic (tax gap and factors affecting it) will be discussed.

Table 1. Past researches

Researcher(s)	Year	Research title	The most important results
Canıkalp et al.	2016	Estimating Value Added Tax Gap in Turkey	The policy gap has always been greater than the compliance gap. In other words, the lost income of the government due to exemptions and reduced rates is more than the lost income from the informal sector of the economy and tax evasion.
Danquah & Assibey	2018	The Effect of Financial and Non-Financial Firms Characteristics on Tax Gap	Fixed level variables such as business type, urban location and company experience have a significant effect on reducing the tax gap.
Qaderi et al.	2018	The Effect of Financial and Non-Financial Firms Characteristics on Tax Gap	Financial characteristics have a positive and significant effect on the tax gap, while non-financial characteristics have a negative effect on the tax gap, although its intensity is not statistically significant.
Alfonso et al.	2018	Spatial dynamic modeling of tax gap: the case of Italy	There is a relationship between the determinants such as operational factors of geographical areas with the relative efficiency of tax avoidance.
Sarin & Summers	2019	Shrinking the Tax Gap: Approaches and Revenue Potential	The analysis suggests that with feasible changes in policy, the IRS could aspire to shrink the tax gap by around 15 percent in the next decade-

Researcher(s)	Year	Research title	The most important results
			generating over $1 trillion in additional revenue by performing more audits (especially of high-income earners), increasing information reporting requirements, and investing in information technology.
Gubara et al.	2020	Games and network structures on corruption, income inequality, and tax control	The initial and final preferences of taxpayers depend on important parameters such as the amount of tax, fine, audit information and costs.
Movahedi Beknazar et al.	2022	Modeling, Survey the Nash Equilibrium and Optimal Tax Fine Rate Determine in the Game of Taxpayers and Tax Affairs Organization	The Nash equilibrium occurs where taxpayers declare their declared tax to be less than the diagnostic tax and the tax affairs organization investigation it carefully.
Hutton	2023	Technical Assistance Report-Revenue Administration Gap Analysis Program-Corporate Income Tax Gap	The estimates for the assessment gap for nonfinancial corporations indicate there may have been an increase in 2012, and then a decline back to the 2011 levels. Under either method, the bulk of the assessment gap appears to be in the manufacturing sector.
Salimian et al.	2023	Modeling Tax Declaration Behavior and Quality of Tax Processing: A Game Theory Approach	The equilibrium expression of taxpayers is a function of diagnostic tax, the quality of investigation groups, the number of investigations and the parameter of dishonesty of taxpayers.
Salimian & Sobhanian	2023	Game Modeling of Collusion and Influential Factors under Uniform Taxpayer Distribution	inverse relationship between the diagnostic tax function of each group of taxpayers and their declared taxes of the same type, as well as the direct correlation between the diagnostic tax function and the declared taxes of the other group of taxpayers

According to the investigations, a lot of research has been done in the field of tax gap (and to a very large extent on tax evasion cases, etc.), some of which have been mentioned. It should be mentioned that the very important topic of collusion between taxpayers and employees of the tax affairs organization is one of the main

and concerns topics of this organization, which has not been addressed in a research in the form of modeling and with the conditions considered in this research. In this research, two main approaches, the first approach presented by Salimian and Sobhanian (2023) and the second approach by Salimian et al. (2023), have been investigated and analyzed. Therefore, the main questions of the research are whether the number of taxpayers, the number of investigation groups willing and unwilling to collude, the tax rate, the benefit resulting from investigation by investigation groups, the number of proceedings and the parameter of dishonesty of taxpayers on the tax gap in what way and how much does it affect? Since there has been no research on the topic of tax gap, the topic of collusion and the quality of investigating groups, which can be one of the main factors affecting the tax gap, therefore, these cases, with a complete analysis of the tax gap from these two important perspectives, are the aspect of novelty and innovation of this research.

This paper is organized in 4 sections. After the introduction, the theory of games is presented in the second part. In the third part, the research method is presented, and in the fourth and final part, there are conclusions and suggestions.

Game Theory

Some researchers compare the importance of game theory design to the discovery of the double DNA spirals and often refer to it as "a theory that can explain everything" (Varoufakis, 2008). It should be noted that game theory can yield results in mutual choice of economic factors based on their preferences that may not have been the focus of any of the factors involved (Owen, 2012). Additionally, game theory focuses on the analysis of rational cooperation and competition between individuals or firms based on mathematical relationships to model the decisions taken by sides of the game involved in the game, who are in conflict (conflict of interest) with each other (Carpenter & Robbett, 2022). Also, game theory allows modelers to think like economists when price theory cannot answer (Gibbons, 1997).

A cooperative game in coalitional form is an ordered pair $< N, v >$, where $N = \{1, 2, \ldots, n\}$ is the set of players, and $v : 2^N \to \mathbb{R}$ is a map, assigning to each coalition $\mathbb{S} \, \epsilon \, 2^N$ a real number, such that $v(\emptyset) = 0$ (Gök & Özcan, 2023). Game theory gives us the tools to describe different type of interactions in a formal way, which gives us hope to get to know and understand them better. Acquiring new, universal knowledge about the phenomena falling within the competition-cooperation spectrum may have a significant impact on the ability to build better organizations and shape the rules of social life (Ozcan et al., 2023).

Game theory modeling has become common in international economics, labor economics, macroeconomics, and public finance, and is progressing toward development economics and economic history. The final goal of this knowledge is to find the optimal strategy for players (Shahbazi & Salimian, 2017). Finally, it

should be said that if game theory tries to provide a unique solution for a game, that solution must be a Nash equilibrium. The Nash equilibrium is reached when each player, according to his belief about the opponent's choice, choose the strategy that will get the most outcomes, secondly, the player's belief is correct, which means that the opponent chooses the strategy formed in the player's belief. The strategies that the players choose in this way constitute their Nash equilibrium strategy (Mas-Colell et al., 1995).

Research Methodology

In this research, two different approaches have been used to obtain the amount of the tax gap, which are discussed separately in the following. It should be noted that the first approach was presented by Salimian and Sobhanian (2023) and the second approach was presented by Salimian et al. (2023).

The first approach

It is assumed in this approach that taxpayers are uniformly distributed in the interval [0, N]. Additionally, suppose that there are two types of groups for investigating taxpayers cases, which will be denoted by i = 1, 2. Each of these two investigating groups provides investigating services but with a difference in the quality of investigating, denoted by 1 and 2 (G_1 , G_2), respectively. Furthermore, assume that the quality of these two investigating groups is generally the same, but group 1 represents a group that has a willing (willing) towards collusion with taxpayers and group 2 represents a group that does not have a willing towards collusion (unwilling) with taxpayers. Additionally, assume that investigating group 1 is located at distance d_1 from point 0, and investigating group 2 is located on the right-hand side of investigating group 1 and at distance d_2 from point N.

Also suppose that of this number of taxpayers, y taxpayers have unwilling collusion with the investigating group, while n taxpayers are willing to collusion with the investigating group in reducing their diagnostic tax (y + n = N). If a non-colluding taxpayer is assumed, then it does not matter to him/her which investigating group investigating his/her case, and he/she only wants to minimize the difference between his/her diagnostic and real income tax. However, the situation is different for a colluding taxpayer, and if a colluding taxpayer is not investigating by his/her preferred group, then his/her utility (benefit) will be reduced by the amount of φ.

Therefore, the utility function of the taxpayer located at point M is as follows:

$$U^M = \begin{cases} -d_1 - t\,|M - d_1| & \text{If investigated by group 1} \\ -d_2 - t\,|M - (1 - d_2)| & \text{If investigated by group 2} \end{cases} \qquad (1)$$

Where t is the tax rate. Finally, according to the model of Salimian and Sobhanian (2023), the declaration tax of two groups willing and unwilling to collude has been obtained as follows:

$$d_1 = \frac{\varphi y + Nt(G_1 - G_2 + 3N))}{3N} \qquad (2)$$

$$d_2 = -\frac{\varphi y + Nt(G_1 - G_2 - 3N))}{3N} \qquad (3)$$

Also, the collection (revenue) function of the tax affairs organization has been obtained as follows:

$$TAX = \frac{\varphi y(2t - 1) + Nt(G_1(2t - 1) + G_2(1 - 2t) + 3N(2t + 3))}{6Nt} \qquad (4)$$

(Salimian & Sobhanian, 2023).

According to the results, this function is decreasing with respect to the number of willing to collusion taxpayers, the willing to collusion investigating group, and undesirability, and increasing with respect to the unwilling to collusion investigating group and increasing number of taxpayers. Now, according to relationships 2, 3 and 4, the tax gap in the model of Salimian and Sobanian (2023) is obtained as follows (relation 5):

$$GAP = \frac{\varphi y(2t - 1) + Nt(G_1(2t - 1) + G_2(1 - 4t) + 3N(3 - 2t))}{6Nt} \qquad (5)$$

The first approach results

Now, according to relation 5, the following results can be presented:

$$\frac{\partial GAP}{\partial y} = \frac{\varphi(2t - 1)}{6Nt} \qquad (6)$$

Considering that the tax rate in Iran's economy is less than 0.5, this result shows that the tax gap decreases with the increase in the number of taxpayers unwilling to collude. This result is clearly defined because the more the number of taxpayers who do not want to collusion increases, then these taxpayers will declare their declaration to a great extent close to diagnosis and this will reduce the tax gap.

$$\frac{\partial GAP}{\partial G_1} = \frac{4t - 1}{6} \qquad \frac{\partial GAP}{\partial G_2} = \frac{1 - 4t}{6} \qquad (7)$$

These results show that as the number of willing to colluding groups with taxpayers (G_1) increases, the tax gap decreases. The interpretation of this result is that since the tax gap is the difference between diagnostic and declared taxation, therefore, if the number of groups willing to collusion increases, then the difference between declared and diagnostic taxes will also decrease (Because the collusion-willing group accepts great extent the declaration of taxpayers by accepting bribes, etc.) and also the difference between the declaration and diagnostic tax of these groups is very close to each other.

On the other hand, the more the number of groups unwilling to collude (G_2) increases, then the tax gap increases, and the interpretation of this result is the opposite of the above result. The interpretation of this result is that since the tax gap is the difference between diagnostic and declared taxation, therefore, if the number of unwilling to collude groups increases, then the difference between declared and diagnostic taxes will also increase (because the difference between the diagnostic tax of the group unwilling to collusion with the declared tax of taxpayers willing to collusion is great).

These important results can reflect many signs to the tax affairs organization, so that if the number of taxpayers willing to collusion is high, then the increase in the tax gap can most likely be a sign of non-collusion between taxpayers and the investigation groups and vice versa.

$$\frac{\partial GAP}{\partial N} = -\frac{\varphi y(2t-1) + 3N^2 t(2t-3)}{6N^2 t} \qquad (8)$$

This result shows that with the increase in the number of taxpayers, the tax gap increases. This result is due to the fact that some of these taxpayers are willing to collusive taxpayers (y + n = N) which, as mentioned in the previous section, will be the basis for increasing the tax gap.

$$\frac{\partial GAP}{\partial t} = \frac{\varphi y + 2Nt^2(2G_1 - 2G_2 - 3N)}{6Nt^2} \qquad (9)$$

This result shows that if $G_1 \geq \frac{2G_2 + 3N}{2}$, the above relationship will be positive. That is, only if the tax rate increases, the tax gap will increase, if $G_1 \geq \frac{2G_2 + 3N}{2}$. Since this relationship will never be established (because the number of willing to collude groups should be more than the number of unwilling to collude groups plus one and a half times the total number of taxpayers), therefore, with the increase in the tax rate, the tax gap will decrease. This result can be interpreted in such a way that in case of an increase in the tax rate, the tax affairs organization expects an increase in its income and this expectation can reduce the risk of collusion between willing to collusion investigating groups and willing to collusion taxpayers, and as a result, the tax gap will be reduced. On the other hand, with the reduction of the

tax rate, these interpretations are reversed and with the reduction of the tax rate, the tax gap increases.

$$\frac{\partial GAP}{\partial \varphi} = \frac{y(2t - 1)}{6Nt} \quad (10)$$

Considering that the tax rate in Iran's economy is less than 0.5, this result shows that with the increase lack of desirability caused by the investigation by a group other than the investigation group willing to collusion, the tax gap decreases. This means that whatever more taxpayers are investigated by a group unwilling to collude, then the taxpayers are forced to provide a high declaration and close to the diagnosis that this factor reduces the tax gap.

The second approach

In this approach, it is assumed that taxpayers are evenly distributed in the range [0, 1]. After paying his due book tax, a taxpayer located at point w on the said interval achieves a surplus of:

$$u(w.i) = R - \frac{1}{1 + r\theta}(w - T_i)^2 + q_i - E_i \quad (11)$$

Where R is the reservation value of sale (products or services and etc.), which is assumed to be high enough so that all taxpayers pay taxes; in other words, the market is fully covered. $\frac{1}{1+r\theta}$ is called probability of non-disclosure (violation) and it means that the taxpayer may not disclose all the facts related to his payment. Here, by r, it is meant an assessment performed by the tax assessment groups, such that the higher is r, the less likely will be non-disclosure of violation ($r \geq 0$). Furthermore, by θ, it is meant dishonesty of the taxpayers such that the higher is θ, the less likely will be non-disclosure of violation ($\theta \geq 0$). w is the taxpayer situation and T_i is the due tax for taxpayer i. q_i is the quality of assessment groups i (it is assumed that the difference in the quality of assessors is unknown to the taxpayers) and E_i is the declared amount by taxpayer i. This equation shows that the assessment groups are different both horizontally and vertically. In order to obtain the effect of the uncertainty of the quality of the assessment groups on the taxpayers' declared tax, it is assumed that q_i is a random value, which is unknown to the taxpayer at the time of declaration.

Assume that the difference in the quality of two assessment groups $(q_i - q_j)$ which is random is in three $H_2 . S . H_1$ states. In addition, suppose that the difference in quality of two assessment groups is in interval [-1/2 , - 1/4], equal to H_1, if the difference in quality of two assessment groups is in interval [-1/4 , 1/4], equal to S, and finally if the difference in quality of two assessment groups is in interval [1/4 , 1/2] it is equal to H_2.

Also assume that the assessment group 1 is in the left side of assessment group 2 ($T_1 \leq T_2$). That means that the due tax of assessment group 1 is less than that of assessment group 2 (assessment group 2 deals with larger taxpayers). Therefore, having relation 6 and that the indifferent taxpayers is located at point z, we have:

$$z^* = \frac{T_1 + T_2}{2} + \frac{(r\theta + 1)(E_2 - q - E_1)}{2(T_2 - T_1)} \qquad (12)$$

Finally, according to the model of Salimian et al. (2023), the equilibrium declared tax of taxpayers 1 and 2 for $0 \leq T_1 \leq T_2 \leq 1$ are:

$$E_1^* = \begin{cases} \dfrac{-q - T_1^2 + 2T_1 + T_2^2 - 2T_2}{(r\theta + 1)} & if & q < -\dfrac{1}{4} \\[3mm] \dfrac{-q(r\theta+1) - T_1^2 - 2T_1 + T_2^2 + 2T_2}{3(r\theta + 1)} & if & q \in \left[-\dfrac{1}{4}, \dfrac{1}{4}\right], \ 0 < z < 1 \qquad (13) \\[3mm] 0 & if & q > \dfrac{1}{4} \end{cases}$$

$$E_2^* = \begin{cases} 0 & if & q < -\dfrac{1}{4} \qquad (14) \\[3mm] \dfrac{q(r\theta+1) + T_1^2 - 4T_1 - T_2^2 + 4T_2}{3(r\theta + 1)} & if & q \in \left[-\dfrac{1}{4}, \dfrac{1}{4}\right], \ 0 < z < 1 \\[3mm] q - \dfrac{T_2^2 - T_1^2}{r\theta + 1} & if & q > \dfrac{1}{4} \end{cases}$$

The expected income (earning) of tax affairs organization is shown by $EI(T_1, T_2)$ which is random based on the difference in quality of two investigating groups. In this condition, the expected income function of investigating groups 1 and 2 will be as:

$$EI_1(T_1, T_2) = \int_{-\frac{1}{2}}^{-\frac{1}{4}} I_1^m(T_1, T_2)\, dF + \int_{-\frac{1}{4}}^{\frac{1}{4}} I_1^c(T_1, T_2)\, dF \qquad (15)$$

$$EI_2(T_1, T_2) = \int_{-\frac{1}{4}}^{\frac{1}{4}} I_2^c(T_1, T_2)\, dF + \int_{\frac{1}{4}}^{\frac{1}{2}} I_2^m(T_1, T_2)\, dF \qquad (16)$$

Where, $F(T) = \frac{2T+1}{2}$ is cumulative distribution function of q parameter. Finally, according to the model of Salimian et al. (2023), the expected income of the two investigating groups will be as follows:

$$I_1 = -\frac{r\theta + 1}{1728(T_1 - T_2)}$$
$$-\frac{8T_1^3 + 8T_1^2(T_2 + 13) - 8T_1(T_2^2 + 14) - 8T_2^3 - 104T_2^2 + 112T_2 - 27}{288(r\theta + 1)} \tag{16}$$

$$I_2 = -\frac{r\theta + 1}{1728(T_1 - T_2)}$$
$$-\frac{8T_1^3 + 8T_1^2(T_2 - 17) + 8T_1(16 - T_2^2) - 8T_2^3 + 136T_2^2 - 128T_2 - 27(r\theta + 1)}{288(r\theta + 1)} \tag{17}$$

(Salimian et al., 2023)

Finally, according to the results, the tax gap in the model of Salimian et al. (2023) is as follows:

$$GAP = -\frac{r\theta + 1}{864(T_1 - T_2)}$$
$$-\frac{16T_1^3 + 16T_1^2(T_2 - 2) - 16T_1(T_2^2 + 35) - 16T_2^3 + 32T_2^2 + 560T_2 - 27(r\theta + 2)}{288(r\theta + 1)} \tag{18}$$

The second approach results

For simplicity in calculations, it is assumed that the diagnostic tax of group 2 (which deals with larger taxpayers) is twice the diagnostic tax of group 1, then:

$$\frac{\partial GAP}{\partial r} = \frac{\theta(r^2\theta^2 + 2r\theta + 1456)}{864(r\theta + 1)^2} \tag{19}$$

This result shows that with the increase in the number of investigating, the tax gap increases. This result can be interpreted as if the taxpayers know that they will be investigated with in several stages, so they will declare their declaration as low as possible and hope that no violation will be discovered (under-declaration). These results are consistent with the results of Salimian et al. (2023). They show that with increase in the number of investigations (r), the declared tax of larger taxpayers will increase and the declared tax of smaller taxpayers will decrease and vice versa. It should also be noted that these results are consistent with the results of Kiral and Mavruk (2018).

$$\frac{\partial GAP}{\partial \theta} = \frac{r(r^2\theta^2 + 2r\theta + 1456)}{864(r\theta + 1)^2} \tag{20}$$

This result also shows that with the increase in the probability of dishonesty of the taxpayer (θ), the tax gap increases. These results are also consistent with the results of Salimian et al. (2023). This result can also be interpreted in such a way that the greater the probability of dishonesty of the taxpayer, the greater the difference between the declared tax (which is very low in this situation) and the diagnostic tax.

Conclusion and Suggestions

One of the main financial sources of governments is tax, and in many countries of the world, the main planning in the field of employment, security, price stabilization, etc. is done based on it. On the other hand, one of the most important and fundamental problems in the field of taxation, especially in developing countries, is the collusion between taxpayers and investigation groups due to the openness of tax laws (with many interpretations), which can be the basis for presenting suggestions from the taxpayers to the investigating groups. These suggestions can be the basis for collusion and noticeable reduction in the collection (income) of the tax affairs organization and ultimately adverse effects on the entire economy. Also, on the other hand, the quality of investigating groups can be considered as a very important factor in creating a tax gap. In this paper, the topic of tax gap is investigated with two approaches. The first approach is a situation where two groups of investigators who are willing and unwilling to collude with two groups of taxpayers who are willing and unwilling to collude with a uniform distribution are placed in the game. The second approach also shows a situation where the probability of not discovering a taxpayer's violation is shown by a mathematical function and the quality of investigating groups for taxpayers who are uniformly distributed is unclear.

The results of the first approach show:

1. With the increase in the number of taxpayers unwilling to collude, the tax gap decreases.

2. As the number of willing to collude groups with taxpayers (G_1) increases, the tax gap decreases.

3. The more the number of unwilling to collude groups (G_2) increases, then the tax gap increases.

4. As the number of taxpayers increases, the tax gap increases.

5. As the tax rate increases, the tax gap decreases.

6. With the increase in the lack of desirability caused by the investigation by a group other than the investigation group willing to collusion, the tax gap decreases.

On the other hand, the results of the second approach show:

1. With the increase in the number of investigators, the tax gap increases.

2. As the probability of dishonesty of the taxpayer (θ) increases, the tax gap increases.

In the end, it is suggested that the tax affairs organization and the tax-related institutions should consider the important factors such as collusion and the quality of the investigating groups and analyze the increase or decrease of this gap with the results of this research in order to more closely examine the very important topic of the tax gap, because according to these results, in the conditions of existence willing to collusion investigating groups, reducing the tax gap will not necessarily be optimal, and vice versa. Therefore, the answers to the main research questions about the impact and severity of the size of the number of taxpayers, the number of willing and unwilling to collude, the tax rate, the benefit resulting from investigation by investigation groups, the number of proceedings and the parameter of dishonesty of taxpayers on the tax gap are given below.

Also, according to the results of this research, the following are suggested strategies to tax affairs organization for reduce the tax gap:

1. The design of tax declarations should be changed in such a way that the declaration of taxpayers is as close as possible to the diagnosis of the investigating group.

2. The tax penalty rate should be determined in such a way that taxpayers have the least desire for collusion and understatement.

3. By designing and setting up the taxpayer system and store terminals, while collecting fair taxes from taxpayers, the tax gap should be reduced.

Finally, it is suggested to consider regional and cultural differences in tax policies in future researches and to use other gaps in tax laws as dummy variables in studies.

Conflict of interest

The authors of this article declare that they have completely followed publishing ethics, including avoiding plagiarism, misbehavior, falsification of data, or double submission and publication, in relation to the publication of the presented article, and there are no commercial interests in this regard.

References

Alfonso, C., Rosaria, V. P. & Stefano, P. (2018). Spatial dynamic modeling of tax gap: the case of Italy. *European Spatial Research and Policy*, 25(1), 7-28.

Amin, Kh, A., & Pirkouho, H, R. (2022). Investigating the Factors Affecting the Tax Gap in Businessman Recipients of Guilan Province from the point of view of tax officials. *Journal of Development Evolution Management*, 13, 345-358.

Becker, G. (1974). A Theory of Social Interactions, Journal of Political Economy, 82 (6), 1063-1093.

Becker, G. (1991). A Note on Restaurant Pricing and Other Examples of Social Influences on Price, Journal of Political Economy, 99 (5), 1109-1116.

Canıkalp, E., Unlukaplan, I., Celik, M MC., & Obrenovic, B. (2016). Estimating Value Added Tax Gap in Turkey. International *Journal of Innovation and Economic Development*, 2(3), 18-25.

Carpenter, J., & Robbett, A. (2022). Game Theory and Behavior. MIT Press .

Danquah, M., & OseiAssibey, E. (2018). The Extent and Determinants of Tax Gap in the Informal Sector: Evidence from Ghana. *Journal of International Development*, 30 (6), 992-1005.

Didar, Hamzeh., Mansourfar, Gholamreza., & Kafami, Mehdi. (2015). The impact of corporate governance mechanisms on the tax gap of listed companies in Tehran Stock Exchange. *Accounting and Auditing Review*, 21(4), 409-430.

Dyreng S.D., Hanlon M., Maydew E.L. (2008). Long-Run Corporate Tax Avoidance. *The Accounting Review*. 83(1), 61–82. https://doi.org/10.2308/accr.2008.83.1.61

Gibbons, R. (1997). An introduction to applicable game theory. Journal of Economic Perspectives, 11(1), 127-149.

Gök, S. Z A., & Özcan, I. (2023). On big boss fuzzy interval games. *European Journal of Operational Research*, 306(3), 1040-1046.

Gubara, Elena., Carrerab, Edgar J. Sánchez., Kumachevaa, Suriya., Zhitkovaa Ekaterina., & Tomilinac, Galina. (2020). Games and network structures on corruption, income inequality, and tax control. Contributions to Game Theory and Management, 13(2020), 152–172.

Hutton, Eric. (2023). Revenue Administration Gap Analysis Program-Corporate Income Tax Gap. *International Monetary FundCountry Report* No. 23/109, 1-39. https://doi.org/10.5089/9798400236457.002

Khalilzaedh Silabi, Zahra., Salimian, Sattar., Shahriyari, Iraj., Pishani Yazdi, Hossein., & Salimian, Salah. (2022). Economic analysis of tax installment forgiveness using game theory approach: The case of Iran. Journal of Sustainable Business, Economics and Finance, 1(3), 1-15. http://doi.org/10.31039/josbef.2022.3.1.24

Khandani Rafsanjani, H., & Sameti, M. (2018). Share of Tax Evasion and Lags in Tax Collection in the Tax Gap. *qjerp* 2018; 25 (4): 65-97.

Kiral, Ersin., & Mavruk, Can. (2018). Corporate Tax Payoff in A Game Theory Approach. *Ege Academic Review*, 18(2), 195-215.

Le, Tuna Minh. Moreno – Dodson, Blanca. Bayraktar, Nihal. (2012). "Tax Capacity and Tax Effort". *Extended Cross – Country Analysis from 1994 to 2009*, Word Bank.

Lisowsky, P. (2010). Seeking Shelter: Empirically Modeling Tax Shelters Using Financial Statement Information. *The Accounting Review.* 85(5), 1693–1720. https://doi.org/10.2308/ accr.2010.85.5.1693

Mas-Colell, A., Whinston, M. D. & Green, J. R. (1995). Microeconomic Theory. London: Oxford University Press.

Movahedi Beknazar, M., Salimian, S., Shahriyari, I., & Pishani Yazdi, H. (2022). Modeling, Survey the Nash Equilibrium and Optimal Tax Fine Rate Determine in the Game of Taxpayers and Tax Affairs Organization. qjfep ,10 (39), 43-65. URL: http://qjfep.ir/article-1-1306-fa.html

Özcan, I., Gök, S. Z. A., & Weber, G. W. (2023). Peer group situations and games with fuzzy uncertainty. Journal of Industrial and Management Optimization, 19(2023). doi: 10.3934/jimo.2023084

Özcan, I., Sledzinski, J., Gök, S., Butlewski, M., & Weber, G. E. R. H. A. R. D. (2023). Mathematical encouragement of companies to cooperate by using cooperative games with fuzzy approach. Journal of Industrial and Management Optimization, 19(10), 1-17.

Owen, G. (2012). Encyclopedia of Applied Ethics. Reference Work, 391-398. Available at: https://doi.org/10.1016/B978-0-12-373932-2.00178-2

Pakdaman, H., Faghani, M, Kh., & Shahab, M R. (2022). The role of bank transactions in the effectiveness of the tax system and reducing the gap

between express taxes and diagnostic and definitive taxes of legal entities. *Economic Jurisprudence Studies*, 4(1), 63-82.

Qaderi, B., Didar, H., & Kafami, M. (2019). Political Costs and Tax Gap. Journal of Empirical Research in Accounting, 9(2), 161-194.

Qaderi, B., Kafami, M., & Karimi, F. (2018). The Effect of Financial and Non-Financial Firms Characteristics on Tax Gap. *Journal of Accounting and Management Vision*, 1(2), 1-16.

Salimian, Salah., Movahedi Beknazar, Mahdi., Salimian, Sattar. (2023). Modeling Tax Declaration Behavior and Quality of Tax Processing: A Game Theory Approach. Journal of Tax reform, 9(1), 64-75.

Salimian, Salah., & Sobhanian, Mohammad Hadi. (2023). Game Modeling of Collusion and Influential Factors Under Uniform Taxpayer Distribution. Journal of Dynamics and Games, 10(4). 1-13. doi: 10.3934/jdg.2023016

Sarin, Natasha., & Summers, H, Lawrence. (2019). Shrinking the Tax Gap: Approaches and Revenue Potential. Working Paper 26475. http://www.nber.org/papers/w26475. DOI 10.3386/w26475.

Scott, D., Hanlon, M., & Maydew, E. (2010). The Effects of executives on corporate tax avoidance. The Accounting Review, 85(4), 1163-1189.

Shahbazi, K., & Salimian, S. (2017). Expansion of Location Theories of Firms and Products' Consistency Using Triangular Distribution Approach. Iranian Economic Review, 21 (3), 497-518

Varoufakis, Y. (2008). Game Theory: Can it Unifying the Social Sciences? Organization Studies, 29(8), https://doi.org/10.1177/0170840608094779.

Wenzel, M. (2002). The Impact of Outcome Orientation and Justice Concerns on Tax Compliance. Journal of Applied Psychology, 87(4), 629-645.

Wilson R.J. (2009). An Examination of Corporate Tax Shelter Participants. *The Accounting Review*. 84(3), 969–999. https://doi.org/10.2308/accr.2009.84.3.969

HOW TO CITE THIS ARTICLE

Sobhanian, M. H., Salimian, S., & Ashrafi, A. (2023). Analysis of the Tax Gap and Its Affecting Factors Using Game Theory Approach. *International Journal of Management, Accounting and Economics*, *10*(10), 748-764.

DOI: 10.5281/zenodo.10429430

URL: https://www.ijmae.com/article_184174.html