

# OPTIMAL AUDITING FOR TAX EVASION

A Master's Thesis

by

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October 2016

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OPTIMAL AUDITING FOR TAX EVASION

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by  
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To my family

**ABSTRACT**  
**OPTIMAL AUDITING FOR TAX EVASION**

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In tax evasion literature, many studies take tax rate, penalty rate, and audit rate exogeneously. The main aim of this study is to endogenise the audit rate and differentiate utility function for taxpayers according to their risk parameters. Tax payers decide whether or not to evade depending on tax rate, penalty rate, and audit rate imposed by the government and their own risk behavior, from there the rate of evaders is found. And by using this rate, the audit rate that maximizes the tax revenue function is found. Our results show that, in some cases while the highest audit rate provides the maximum tax rate, in other cases lower audit rate maximizes the tax revenue depending on the level of tax rate and penalty rate.

*Keywords:* Tax evasion, Expected Utility Theory, Risk Perception

# **ÖZET**

## **VERGİ KAÇAKÇILIĞI İÇİN OPTİMAL DENETİM**

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Vergi kaçırma literatüründe birçok çalışma vergi oranını, ceza oranını ve denetim oranını eksojen olarak alıyor. Bu çalışmanın asıl amacı denetim oranını endojenize etmek ve mükellefleri risk parametrelerine göre farklılaştırmaktır. Devletin belirlediği vergi oranı, ceza oranı ve denetim oranına göre ve kendi risk davranışlarına göre mükellefler vergi kaçırıp kaçırmama kararını verir, buradan toplumdaki vergi kaçırmanın oranı bulunur. Ve bu oran kullanılarak gelir fonksiyonunu maksimize eden denetim oranı bulunur. Sonuçlarımızda vergi oranı ve ceza oranına bağlı olarak bazı durumlarda en yüksek denetim oranını maksimum vergi geliri sağlarken bazı durumlarda daha düşük seviyedeki denetim oranı vergi gelirini maksimize etmektedir.

*Anahtar sözcükler:* Vergi kaçırma, Beklenen Değer Teorisi, Risk algısı

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# CHAPTER 1

## INTRODUCTION

Tax evasion is as old as tax itself. It is a phenomenon that affects both developed and developing countries. Even though estimates regarding the extent of evasion are subject to some uncertainty, Franzoni (1998) states that while Western industrialized countries evade tax at amounts between 5% and 25% of potential tax revenue but, less developed countries evade tax at amounts up to 30 to 40%. However this depends on the technique used and the country.<sup>1</sup>

Probably the most common of all economic crimes is tax evasion, and the analysis of tax compliance has grown substantially over the past twenty years (Cowell, 1990). Tax evasion occurs when individuals consciously fail to comply with their tax obligations. But tax avoidance differs from tax evasion in being unlawful; there is no penalty for avoidance. Although there is a constitutional difference between them they have very strong similarities when we consider their economic functions. And it's really hard to know which is which. And for that reason it's also difficult to pinpoint the actual amount of the tax gap.<sup>2</sup>

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<sup>1</sup> see for developed countries Feige (1989), Pyle (1989) and Thomas (1992), and for less developed countries see Tanzi and Shome (1994).

<sup>2</sup> see for instance Feldman and Kay (1981) and Cowell (1990)

Determining the extent of evasion is not as easy as it seems, and there are many reasons for this. The extent of tax evasion cannot be determined straight away. For example, if we were to conduct a survey to detect tax evasion directly for the government or another external observer who wants to know the extent, and ask the people surveyed whether they evade or not, and if they do, how much of the obligatory tax they evade by hiding exact amount of their income, they will avoid giving the correct answer, because tax evasion is a crime and they are afraid that they will be detected through this survey. According to Baumister (1982) because tax evasion is both sensitive issue and holds the risk of exposing oneself, reports such as surveys are prone to serious underreporting.

The basic framework of literature analysis for tax evasion dates back to Allingham & Sandmo (1972), which was built on a seminal model of crime by Becker (1968). Since then, tax evasion has been investigated from every perspective. Although some of the empirical research was originally based on theoretical structure, surely the empirical work, experimental work and the policy discussions motivated further theoretical work and that theory in return gave fresh vision for empirical research. Literature on tax evasion has sometimes even produced controversial results. Main factors of tax evasion are tax rate, audit rate and penalty rate. Literature review on these factors will be provided in detail below respectively.

Expected utility theory is a benchmark for this literature, but the predictions made by Yitzhaki (1974) and Allingham & Sandmo (1972) regarding the relationship between tax rate and tax evasion claim that tax evasion decreases with increasing tax rate, however this result was later disproved with a great number of empirical and experimental studies.<sup>3</sup> Some studies in this literature suggest some solutions to Yitzhaki Puzzle. For example, if the tax payer is deciding whether or not to evade tax on the Prospect Theory by Kahneman & Tversky (1979) instead of the Expected Utility Theory, it can be seen that theoretical analysis are consistent with empirical and experimental analysis. Another solution for this puzzle comes from the method of tax collection. While advance tax payment has no impact on the tax payers'

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<sup>3</sup> In the literature, this is referred to as the Yitzhaki puzzle.

evasion decision under the Expected Utility Theory, it does effect the decision to evade under Prospect Theory (Yaniv, 1999).

On the contrary, many empirical works has found that high tax rate increases tax evasion or sometimes gives ambiguous results. Kirchler, Hoelzl & Wahl (2008) have summarized literature on effects of tax rate on tax evasion, noting some studies which have shown that evasion increases with marginal tax rates (Pommerehne & Weck-Hannemann, 1996); (Weck-Hannemann & Pommerehne, 1989). Also of Clotfelter (1983) and Slemrod (1985) found that the marginal tax rate has a significant effect on underreporting, while on the contrary a study conducted by Porcano (1988) found that it has no effect on tax evasion. (Alm, Jackson, & McKee, 1992), (Collins & Plumlee, 1991) , (Friedland et al., 1978), (Park & Hyun, 2003) showed that increasing in the tax rate results in higher tax evasion. But Alm, Sanchez, & deJuan (1995) found the opposite in their study for Spain, and Baldry (1987) did not find any significant effect.

Empirical studies on the effect of penalty rates on tax compliance did not come up with the expected results. Basically, the relationship between penalty rate and tax evasion has shown incompatible findings (Fischer et al., 1992). In some experiments it was seen that penalty rate was slightly higher related to tax compliance than audit probabilities (see Park & Hyun, 2003). Friedland et al. (1978) found that higher penalty rates are more effective deterrents than higher audit rates. Other experimental studies on the other hand, showed that penalty rates and tax evasion are not related, but audit probabilities and tax evasion are related (Friedland, 1982); (Webley et al., 1991)

Researches on the effect of audit rates on tax evasion were found to be weak. Sometimes even results can be counter-intuitive. In one example Slemrod et al. (2001) conducted an experiment to analyze the effect of audit rate on tax compliance. In the experiment conducted in Minnesota they separated 1724 randomly selected taxpayers into three different groups according to their income: low, medium and high. As expected, participants with low and medium income, compliance increased with the audit rate, but interestingly, the compliance of participants with high income

decreased with higher audit rate. As it can be seen from these results, experimental studies need to be treated carefully. Webley & Halstead (1986) concluded that to be effective, experimental studies has to be more realistic. Because in their experiments most participants reacted to the experiment like in a game and said that if this was real life, they would behave differently when declaring tax. The review made by Fischer et al. (1992) also summarized inconsistent findings on audit rates and tax evasion. Laboratory experiments differing audit rates found low negative effects of audit rates on evasion, particularly for precise rate of audit instead of demonstrating high, middle, and low rates (Spicer & Thomas, 1982). On the contrary, other experimental studies showed that inaccurate information leads to a decrease in tax evasion (Friedland, 1982). Some surveys found significant and non-significant low positive relations between audit rates and tax evasion (Mason & Calvin, 1978); (Song & Yarbrough, 1978); (Spicer & Lundstedt, 1976); (Wärneryd & Walerud, 1982). An analysis on tax compliance and audit rates made by Andreoni et al. (1998) showed that objective audit rates have little effect on evasion, and come to the conclusion that subjectively perceived probabilities has the probability of being resolved via psychological variables.

Alongside tax rate, audit rate and penalty rate, it has been searched that different factors effecting tax evasion. From among these researches some results are as follows; Alm et al. (1992) made an analysis about the relationship between tax evasion and community interest and he found that tax evasion is lower when tax income is used to provide a public good. While et al. (1991) argued that the decision to evade or not is made together with the decision on how much effort to make in income earning, Baldry (1986) focused on the shameful aspect of tax evasion by saying that a large group of people never cheat because they believe that cheating is wrong. In their experimental study Giese and Hoffman (1999) found that tax evasion increases with the raising income, and that females evade tax less than males.

After the neoclassical approach in economics, Allingham & Sandmo (1972) and Srinivasan (1973) assumed that taxpayers are expected to be utility maximizers of their taxable income, that is, rational optimizers who declare a small amount of their income as possible, influenced by tax rate, penalty rate and audit rate, whose choice

behavior complies with the Von Neumann-Morgenstern axioms. A taxpayer decides to whether evade or not by weighing costs and benefits of compliance with the expected utility of evasion.<sup>4</sup> However because every individual, therefore every society has a different risk perception, in this study we have made a comparative analysis of societies which have different distribution of risk parameters.

As mentioned, tax compliance decision depends on tax rate, audit rate, penalty rate, income level and risk perception. Most theoretical models take the tax rate, penalty rate, audit rate exogenously. The main issue of this study is to endogenize audit rate in the tax evasion concept. As mentioned, because we have differentiated participants according to their risk perception, for the sake of simplicity, we suppose that everyone has the same income. In this study, we are examining, in which risk degree societies what audit rate will provide the maximum income for the government or the tax authority, in the given tax rate and penalty rate.

This thesis is structured as follows: in the next section we introduce the fundamentals of the model and explain the variables. In section 3, we give the details of the model. In section 4 we provide the results of the numerical analysis and in section 5, we make some further analysis on tax evasion. In the final section, we make a conclusion for our analysis.

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<sup>4</sup> Interestingly, Allingham and Sandmo (1972) and Srinivasan (1973) published their works and findings on tax evasion about the same time without knowing each other's work.

## CHAPTER 2

### FUNDEMANNTALS OF THE MODEL

In a tax system there are three main parameters; tax rate,  $t$ , which is a number less than 1, penalty rate,  $\lambda$ , which is a number greater than 1, audit rate,  $p$ , which is a number less than 1. Here we have two assumptions:

Assumption 1:  $t\lambda$  cannot be bigger than 1.<sup>1</sup>

Assumption 2: the implemented maximum audit rate is 0.5

We also assume that the utility which comes from income is not linear. As mentioned before it depends on risk perception of the taxpayer. So we choose the utility function for tax payer as,

$$U(x) = x^\alpha .$$

Let  $I$  be the income and  $x$  be the income after tax payment if taxpayers pay their tax then  $x$  is equal to  $I - It$ , if taxpayers don't pay their tax and get caught then  $x$  is equal to  $I - It\lambda$ , if taxpayers don't pay their tax and don't get caught then  $x$  is equal to  $I$  and  $\alpha$

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<sup>1</sup> This is necessary because if a person is caught evading tax, we cannot get more than his or her income.

is the risk parameter of the tax payer; if  $0 < \alpha < 1$  then the individual is risk averse, if  $\alpha = 1$  then the individual is risk neutral, if  $\alpha > 1$  then the individual is risk loving.

As seen in Figure 1 the utility function is concave (from below) for a risk averse person, convex (from below), and it is linear for a risk neutral person.

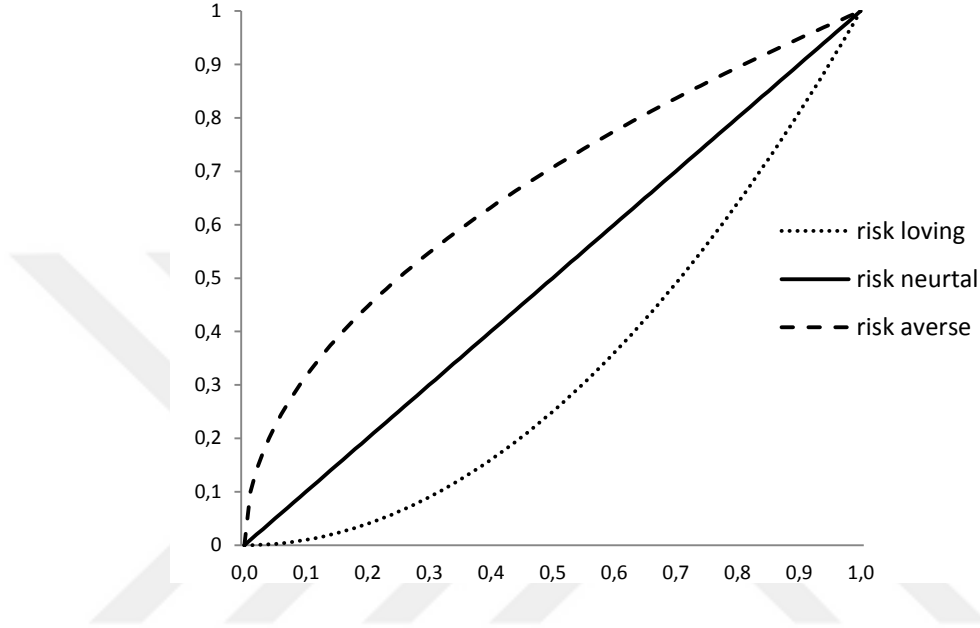


Figure 1: Utility functions for different risk behavior

The model has two sides; first is the taxpayer side where taxpayer maximizes his/her income after tax payment. There are two decisions to make; evade or not evade. And the utility that comes from these decisions are as follows;

$$\text{➤ evade: } U_1 = p[I(1 - t\lambda)]^\alpha + (1 - p)I^\alpha \quad (2.1)$$

$$\text{➤ not evade: } U_2 = [I(1 - t)]^\alpha \quad (2.2)$$

Hence one needs to maximize his/her utility as follows;

$$U(w; I, p, t, \lambda, \alpha) = \max\{ p[I(1 - t\lambda)]^\alpha + (1 - p)I^\alpha; [I(1 - t)]^\alpha \}. \quad (2.3)$$

Here  $I$  is the income and  $w$  is the wealth.

Second is the government side where government maximizes its tax revenue. Government's tax revenue function has three components which are tax income,



audit penalty income and audit cost. Tax income is the tax payment that comes from honest taxpayers; audit penalty income is penalty payment that comes from the taxpayers who are detected and has not paid his/her tax and finally audit cost is cost of detecting evaders. Hence utility function of government can be written as follows;

$$U_{gov} = \text{tax income} + \text{audit penalty income} - \text{audit cost} . \quad (2.4)$$

Here we choose the utility function of government as,

$$U(x) = x^2.$$

In this power utility function,  $x$  is gain for tax income and penalty income, but loss for audit cost. We assume risk parameter as 2 but results are almost same for increasing value of the risk parameter.<sup>2</sup>

$$U_{gov} = r(p)NIt + (1 - r(p))p\lambda NIt - c(r(p)NIt + (1 - r(p))p\lambda NIt) \quad (2.5)$$

In this function,  $N$  is the number of taxpayers,  $r(p)$  is the proportion of taxpayers who do not evade,  $c$  is the cost parameter. Detailed explanation of these functions will be provided in the next section (see page 9).

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<sup>2</sup> In our analysis we have researched the results of government utility function with different risk parameters, however, because the results were very close, only the results with a risk parameter of 2 will be given.

## CHAPTER 3

### THE MODEL

The interpretation of the taxpayer side is that if the tax payer decides to evade, his/her utility comes from the expected utility function (2.1). As shown in the equations (2.1) and (2.2) the evasion decision is binary, either a taxpayer pays his/her entire tax payment which s/he is obligated to pay, or s/he evades completely.

As we mentioned before, the system has two sides. The first one is the tax payer's side and the second one is the government (or tax authority) side. The main issue of this study is endogenizing audit rate which is taken as exogen in numerous studies in the literature. The mechanism is that firstly, the government determines the tax rate, penalty rate, and audit rate then according to these values and their own risk parameters, taxpayers decide whether or not to evade tax. Here we assume that risk parameters are in gamma distribution. To find the risk parameter of a person who is indifferent to deciding whether or not to evade, we equate the expected values in case there is an evasion and there is no evasion. In other words, we need to equate equations (2.1) and (2.2). Before that we will explain the aforementioned equations.

The left hand side of the equation (3.1) gives the calculations of expected utility when the tax payer decides to evade. Calculation will be made as follows: if taxpayer is audited with probability  $p$ , the tax rate that has been imposed has to be multiplied by the penalty rate and then the resulting amount will be taken as

$$I - (It)\lambda.$$

But if taxpayer is not audited with  $(1-p)$  probability his/her entire income will be left to him/her.

The right hand side of the equation shows the utility that comes from after-tax income of the honest taxpayers who pay the tax they are supposed to pay. After tax income calculation is given as follows:

$$I - It.$$

Consequently the taxpayer is indifferent the point at which these two equations give the same utility. Basically at this point the expected utility gained in evading tax is equal to the expected utility gained in not evading tax. We name the risk parameter of this indifferent taxpayer  $\alpha^*$ . Individuals whose risk parameter is higher than the critical risk parameter  $\alpha^*$  will evade because the expected utility gaining from the left hand side of the equation gives the higher value.

$$p[I(1 - t\lambda)]^\alpha + (1 - p)I^\alpha = [I(1 - t)]^\alpha \quad (3.1)$$

Since there is no analytical solution to this equation, we will conduct numerical analysis to find  $\alpha^*$ . The results of this analysis will be provided in the next section in greater detail.

Recall that risk parameters of taxpayers are in gamma distribution. A random variable  $X$  that is gamma-distributed with shape  $k$  and scale  $\theta$  is denoted by

$$X \sim \Gamma(k, \theta) \equiv \text{Gamma}(k, \theta)$$

The probability density function using the shape and scale parameterization is

$$f(x; k, \theta) = \frac{1}{\Gamma(k)\theta^k} x^{k-1} e^{-\frac{x}{\theta}} \quad \text{for } x > 0, k > 0 \text{ and } \theta > 0$$

Here  $\Gamma(k)$  is the gamma function evaluated at  $k$ .

As explained above  $\alpha^*$  is the threshold for making a decision to evade tax. While  $r(p)$  is the rate of taxpayers who do not evade tax,  $1-r(p)$  is the rate of taxpayers who evade tax. Hence we have:

$$1 - r(p) = \frac{\int_{\alpha^*}^{\infty} f\left(\frac{1}{\Gamma(k)\theta^k} x^{k-1} e^{-\frac{x}{\theta}}\right) d\alpha}{\int_{-\infty}^{\infty} f\left(\frac{1}{\Gamma(k)\theta^k} x^{k-1} e^{-\frac{x}{\theta}}\right) d\alpha}$$

While the numerator on right hand side of the equation is the rate of the evaders, the denominator is the rate of all the tax payers. Note that the denominator is automatically equal to 1. Hence the rate of the non-evaders is basically calculated as follows:

$$r(p) = 1 - \int_{\alpha^*}^{\infty} f\left(\frac{1}{\Gamma(k)\theta^k} x^{k-1} e^{-\frac{x}{\theta}}\right) d\alpha \quad (3.2)$$

Gamma distribution with three different parameters can be seen in Figure 2. The increasing  $\theta$  value shows societies with a higher risk parameter. In the figure, the distribution illustrated with the straight line shows societies with a lower risk parameter. The dotted line shows societies with a higher risk parameter. And the dashed line shows societies with a relatively medium risk parameter.

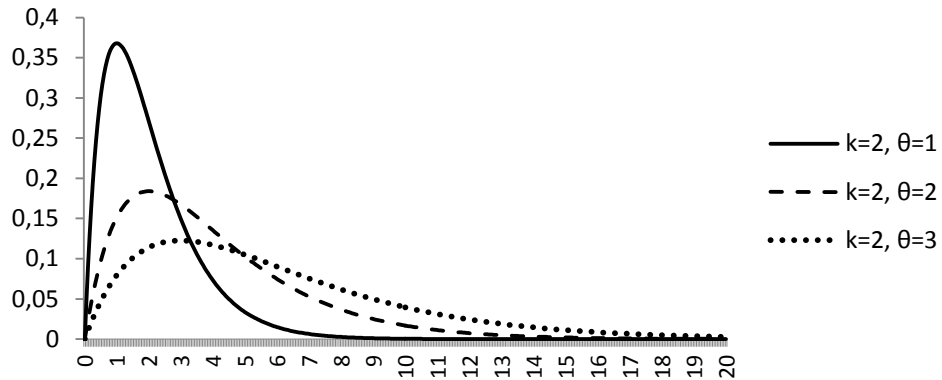


Figure 2: Gamma distribution for different values of  $k$  and  $\theta$

The rate of non-evaders is used by the government to maximize its tax income. As mentioned in the previous chapter, the government's utility function is composed of three components. We will now look closely at each of these components.

The first component of the equation (2.5), which is the tax income, is calculated in this way: when the rate of non-evaders is multiplied with the total number of taxpayers, we obtain the total number of non-evaders. Then we multiply this with the income to find the total taxable income. For the sake of simplicity, we suppose that all taxpayers have the same income. Lastly when we multiply this amount with the tax rate, we find the total tax amount that has to be collected as:

$$\text{tax income} = r(p)NIt.$$

The second component of the equation is composed of amounts coming from the penalty imposed by the tax authority. This amount is calculated as such: When we multiply the rate of evaders with audit rate, we find the number of evaders after audit. If we multiply this rate with the number of taxpayers and income, we find the number of evaders and taxable income of evaders respectively. However, because these individuals are tax criminals, we find the rate which they have to pay by multiplying the tax rate with penalty rate:

$$\text{audit penalty income} = (1-r(p))pNIt\lambda.$$

The final component of the equation is composed of audit cost. Here,  $c$  is the unit audit cost of the government, that is the cost of collecting 1 dollar of tax. And this rate changes from one country to another. In this model, we use the unit audit cost of United States. In the United States, the cost of collecting 100 dollars of tax is 41 cents, namely,  $c$  is equal to 0.0041 (Laffer et al, 2011)<sup>1</sup>. The tax payment coming from honest taxpayers and the penalty amount coming from evaders who are caught forms the total tax income of the government. And if we multiply this amount with  $c$  we obtain the audit cost:

$$\text{audit cost} = c(r(p)NIt + (1 - r(p))p\lambda NIt)$$

Consequently, if we rewrite the equation (2.5), we come up with this:

---

<sup>1</sup> When we look at the cost of collecting 100 dollars of tax in Singapore between the years 2000-2015, we see that it is equal to 0.87 (Government of Singapore, 2016). Economist Sukru Kizilot concludes that the cost of collecting 100 TL is 68 krs in Turkey (Kizilot, 2013). And the comparative analysis of these two countries it was seen that the same results were reached.

$$U_{gov} = NIt[[r(p)]^2 + [(1 - r(p))p\lambda]^2 - [c(r(p) + (1 - r(p))p\lambda)^2] \quad (3.3)$$

It can be seen from equation (3.3), the governments income maximization is independent of N and I. Moreover, the rate of non-evaders  $r(p)$  from the tax payer side also depends on  $t$ .



## CHAPTER 4

### NUMERICAL ANALYSIS

In this chapter, we have primarily worked with data retrieved from the US Tax System. Data from a few different countries are also employed to get comparative results. The analysis is as follows firstly, we selected two tax rates among seven different ones,<sup>1</sup> for the lower tax rate we chose 15% and for the higher tax rate we chose 35%. Afterwards we selected the low and high penalty rates that can be implemented. While these two variables are control variables, the audit rate is a manipulated variable. In addition, we separated the taxpayers as low risk profile, medium risk profile and high risk profile.<sup>2</sup>

The mode is the value that appears most often in a set of data, in other words, the mode of a continuous probability distribution is the value  $x$  where the probability density function is at its maximum value. The mode of Gamma distribution with the shape parameters  $k$  and scale parameters  $\theta$  is  $(k-1)\theta$  for  $k > 1$ . Hence  $k=2$  implies the mod is equal to  $\theta$ .

---

<sup>1</sup> Marginal tax rates in the US are as follows: 10%, 15%, 25%, 28%, 33%, 35%, 39.6%.  
See (International Revenue System, 2015)

<sup>2</sup> The reason why we have included different analysis is that countries can select the appropriate analysis for them after determining the risk profile of their own tax paying citizens.

In this case, we start our analysis by choosing  $\theta$  as the risk parameters of taxpayers. We assume that the risk parameter is chosen according to the majority of the population. In other words, we assume that  $\theta$  increases with the number of risk lovers in the population. Therefore, in the distributions we have selected  $k$  is equal to 2, we differentiated  $\theta$ . For the low risk profile societies,  $\theta$  is equal to 1, in medium risk profile societies,  $\theta$  is equal to 2, and in high risk profile societies  $\theta$  is equal to 3. As mentioned in chapter 2, a person with a risk parameter lower than 1 is risk averse, a person with a risk parameter of 1 is neutral, and a person with a risk parameter higher than 1 is risk loving. As  $\theta$  increases, a person takes more risk.

Figures in the rest of this chapter compare the societies which have different risk parameters. The dashed lines show societies with a mode of gamma distribution that is lower than 1. The dotted lines show societies with a mode of gamma distribution that is equal to 1. The straight lines show societies with a mode of gamma distribution that is more than 1.

While the y-axis of these graphs shows the (3.3)'s inner part of the parenthesis, that is,  $[r(p)]^2 + [(1 - r(p))p\lambda]^2 - [c(r(p) + (1 - r(p))p\lambda)]^2$ , the x-axis shows the government's audit rate.

#### 4.1 Low Tax Rate

Here the tax rate is 15%. The penalty imposed for this tax rate is 3 for low penalty rate and 6 for high penalty rate.<sup>3</sup> A comparative analysis will be made to compare the different risk behaviors of tax payers using these penalty rates.

As it can be seen in Figure 3, when the penalty rate is low, everyone evades tax independent of the tax payers' risk parameter up to audit rate of 0.26 since the penalty rate is low. Hence all graphs are overlapped in this region<sup>4</sup>

<sup>3</sup> In this tax rate the penalty rate we will take is 6 because  $t\lambda$  cannot be greater than 1.

<sup>4</sup> In our analysis, in the low penalty rates independent of the tax rate up to a certain point the graphs overlap.



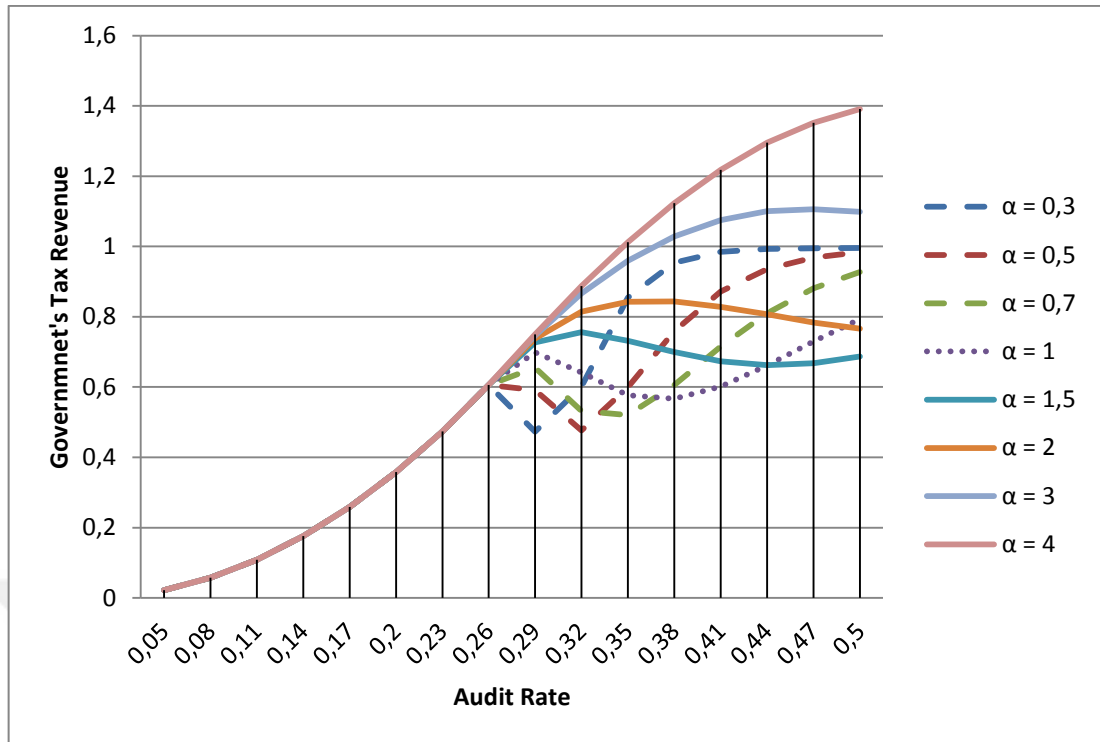


Figure 3: Government's tax revenue for taxpayers which have different risk parameters where tax rate is 15% and penalty rate is 3.

The government's tax revenue function for risk averse and risk neutral tax payers is monotone after the audit rate of 0.35, this means that after this point the governments tax revenue increases with audit rate but all these graphs converge to one. If y-axis is equal to 1 then the (3.3) is equal to  $NIt$ . This gives the total amount of tax income if everyone pays their taxes honestly.<sup>5</sup> But for the risk loving tax payers the revenue function is not monotone, rather it increases up to a certain point, and then starts to decrease. As shown, the audit rate at the maximum points increase as the risk parameter increase, but after the risk parameter of 3, government's tax revenue function become monotone increasing.<sup>6</sup>

<sup>5</sup> In this case the audit rate in such a society will be 0.

<sup>6</sup> We found in our analysis that the utility function with risk parameters that are higher than 4 are also monotone. Because of this, the results have not been provided in the analysis.

**Case 2.  $t=15\%$ ,  $\lambda=6$  (High penalty rate)**

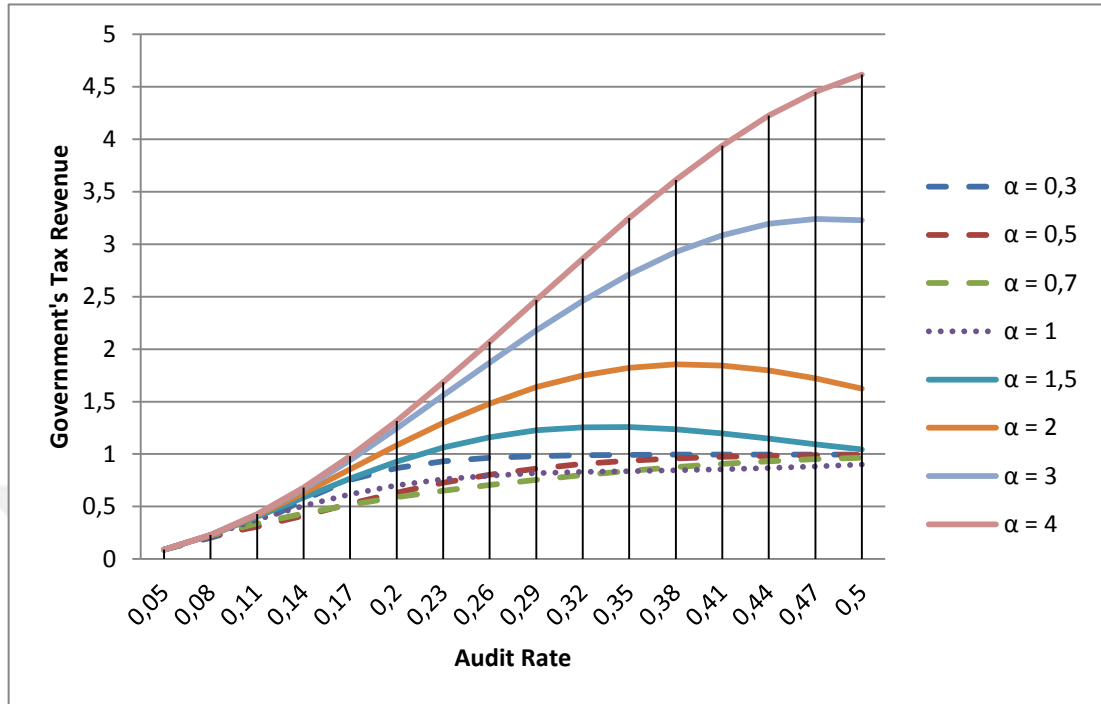


Figure 4: Government's tax revenue for taxpayers which have different risk parameters where tax rate is 15% and penalty rate is 6.

As it can be seen in figure 4, contrary to case 1, because the penalty rate is high, there are tax payers who do not evade tax in all risk parameters up to 0.05 audit rate. Hence, all the graphs overlap up to this point. The government's tax revenue function for risk averse and risk neutral tax payers is monotone increasing from the beginning. As mentioned in the case 1, this means that after this point the governments tax revenue increases with audit rate. As in case 1, the graphs converge to 1 for risk averse. For the risk loving tax payers, the behavior of the functions are the same as the previous case but optimum audit rate increased. Moreover, with this penalty rate, the government's tax revenue has increased. For example, while the government's maximum tax revenue is approximately 1.4 for low penalty case, in this case it has increased to an amount above 4.5.

## 4.2 High Tax Rate

Here the tax rate is 35%. Because this is a high tax rate, the penalty rates is lower compared to low tax rate. Consequently, we take 2 as the low penalty rate and 2.75

as the high penalty rate.<sup>7</sup> With the two penalty rates, a comparative analysis will be made to compare the different risk behaviors of tax payers.

**Case 1.**  $t=35\%$ ,  $\lambda=2$  (Low penalty rate)



Figure 5: Government's tax revenue for taxpayers which have different risk parameters where tax rate is 35% and penalty rate is 2.

As it can be seen in Figure 5, even if the tax rate has increased, because the penalty rate is low, all the graphs overlap up to 0.35 because everyone evades tax up to this point. While there is a decrease in the governments tax revenue functions after the overlapping point for risk averse taxpayers who have a low risk parameter of 0.3, after 0.41 it has increased monotonically, the risk averse taxpayers with a risk parameter of 0.5 and 0.7 the optimum audit rate is 0.38.

As seen in the figure, for risk neutral tax payers optimum audit rate compared to risk averse taxpayers is higher at 0.47. Compared to low tax rate, the government's tax revenue function is monotone for the risk averse and risk neutral taxpayers, but here, it is monotone for the risk loving taxpayers.

<sup>7</sup> Because  $t\lambda$  is not greater than 1, the maximum audit rate is 2.75.

**Case 2.**  $t=35\%$ ,  $\lambda=2.75$  (Low penalty rate)

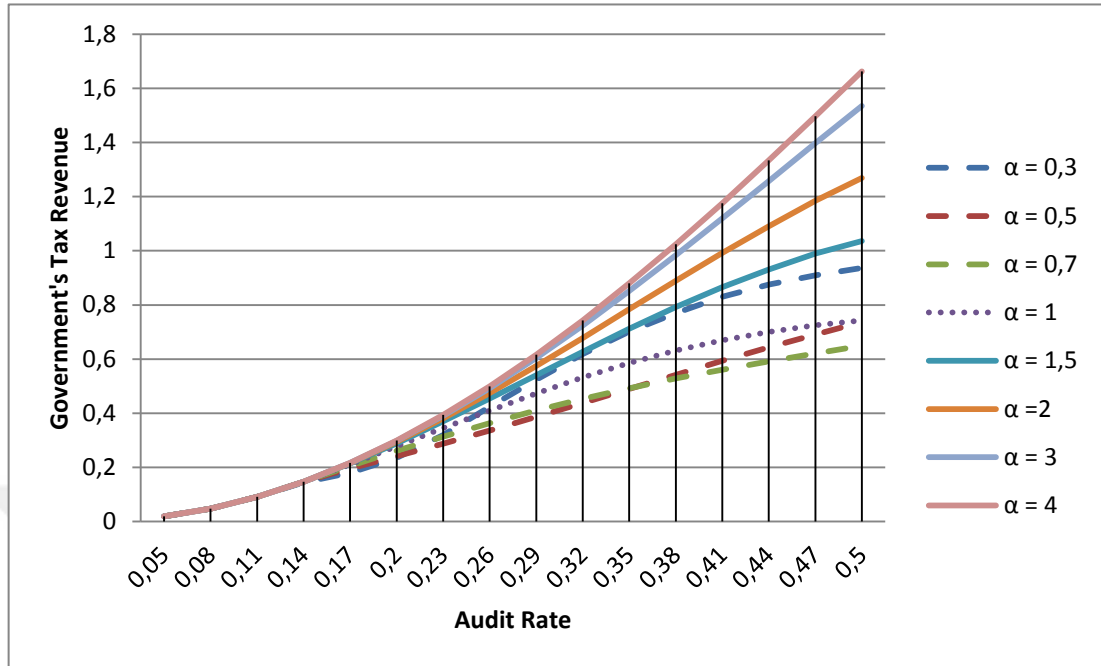


Figure 6: : Government's tax revenue for taxpayers which have different risk parameters where tax rate is 35% and penalty rate is 2.75.

Because the tax rate and penalty rate is high, the government's tax revenue function is monotone increasing for taxpayers with all risk parameters. As mentioned before, because we cannot take the penalty rate very high, as in case 1, up to a certain point even tax payers with a very low risk parameter have all evaded tax, and because of this the graphs have overlapped up to the 0.14 audit rate.

## CHAPTER 5

### FURTHER ANALYSIS

The aim of this study was to find the audit rate that maximizes the tax revenue for governments whose analysis we provided in the previous chapter. Moreover, in order to compare the model with existing literature, the effects of three main factors, tax rate, audit rate and penalty rate on tax evasion were analyzed.

#### 5.1 The effects of Tax Rate on Tax evasion

As mentioned in Chapter 1 there are two different views on the effects of tax rate on tax evasion, while Allingham & Sandmo (1972) and Yitzhaki (1974) have used the Expected Utility Theory to claim that the increase in tax rate decreases the tax evasion, many empirical and experimental studies that have been conducted later on have shown that the increase in tax rate increases the tax evasion.

We have previously mentioned that equation (3.1) did not have an analytical solution, but if we rewrite the equation where  $\alpha$  is equal to 1, that is, for risk neutral individual we come up with this:

$$p[I(1 - t\lambda)] + (1 - p)I = [I(1 - t)]$$

If we rewrite the equation once again:

$$pI - pIt\lambda + I - pI = I - It$$

When we solve the above equation, we get  $p\lambda = 1$ . That is to say the condition that leaves the risk neutral taxpayer indifferent, is the condition where  $p\lambda$  equals to 1. And the utility that comes from these decisions are as follows;

➤ evade:  $U_1 = I - It(p\lambda)$

➤ not evade:  $U_2 = I - It$

Hence, where  $p\lambda$  is greater than 1 if the risk parameter of the taxpayer is greater than 1, they choose to evade. If we look at the different cases for  $p\lambda$ :

### Case 1: $p\lambda < 1$

As it can be seen in the graph, where  $p\lambda$  is less than 1, as the tax rate increases, the rate of evaders and consequently tax evasion decreases, which is consistent with the findings of Allingham & Sandmo (1972) and Yitzhaki (1974). Moreover, as the taxpayers' risk parameter increases, as seen in the slope of the graphs in Figure 7, decrease in the amount of the rate of evaders has decreased.

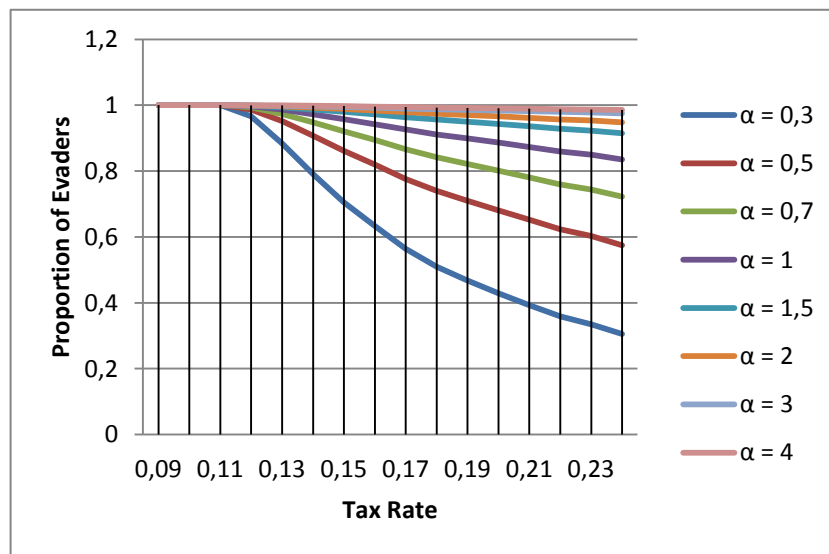


Figure 7: Tax evasion for taxpayers which have different risk parameters for tax rate where  $p\lambda < 1$

### Case 2: $p\lambda=1$

Where  $p\lambda$  is equal to 1, utilities that come from the decisions to evade or not evade are the same. As it can be seen from the Figure 8 proportion of evaders is independent from the tax rates. Therefore in all the tax rates the amount of tax evasion is equal. But for different risk parameters of taxpayers, rate of evaders increases as risk parameter increases.

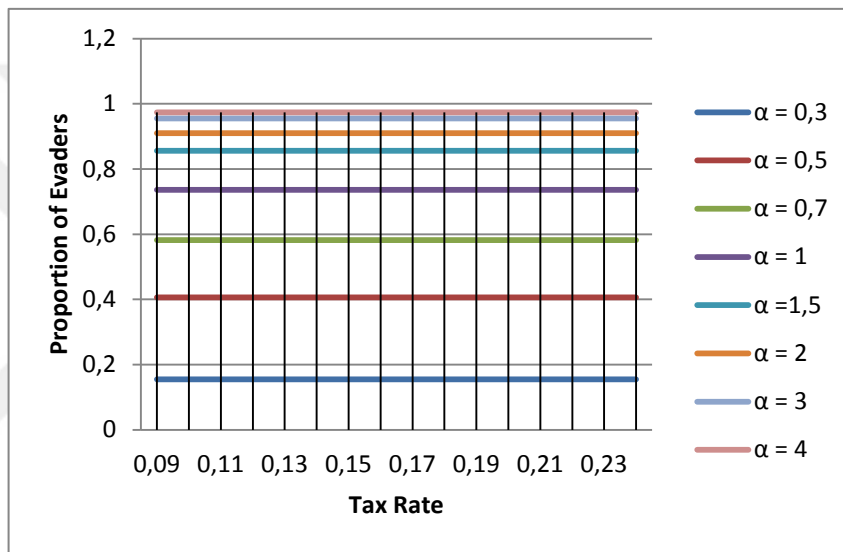


Figure 8: Tax evasion for taxpayers which have different risk parameters for tax rate where  $p\lambda=1$

### Case 3: $p\lambda>1$

As mentioned in the introductory chapter, and as supported by a large number of the literature where  $p\lambda$  is larger than 1, as the tax rate increases, the rate of evaders and consequently tax evasion increases. Moreover, as the taxpayers' risk parameter increases, and as seen in the slope of the graphs in the Figure 9, increase in the amount of the proportion of evaders has increased.

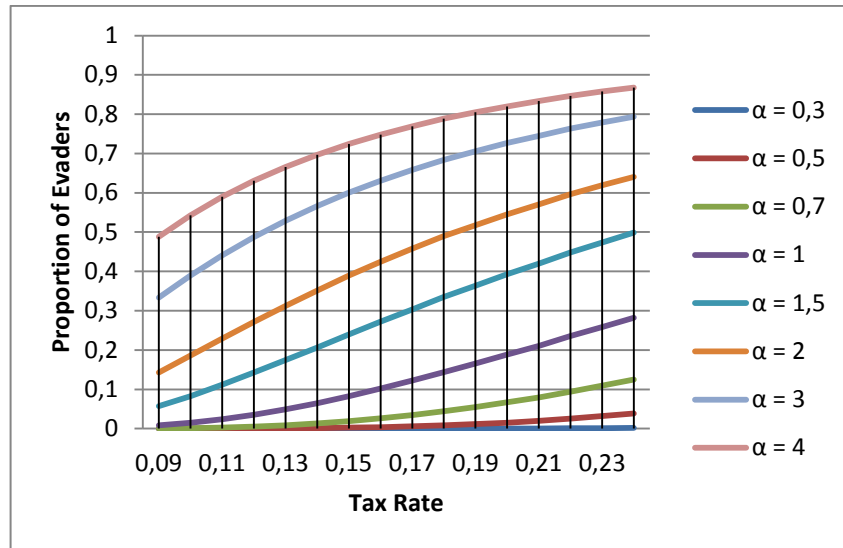


Figure 9: Tax evasion for taxpayers which have different risk parameters for tax rate where  $p\lambda > 1$

## 5.2 The Effects of Penalty Rate on Tax Evasion

As seen in Figure 10, as penalty rate increases, the rate of evaders and consequently tax evasion decreases. Moreover, as the taxpayers' risk parameter increases, and as seen in the slope of the graphs in Figure 10, a fall in the amount of the proportion of evaders has decreased.

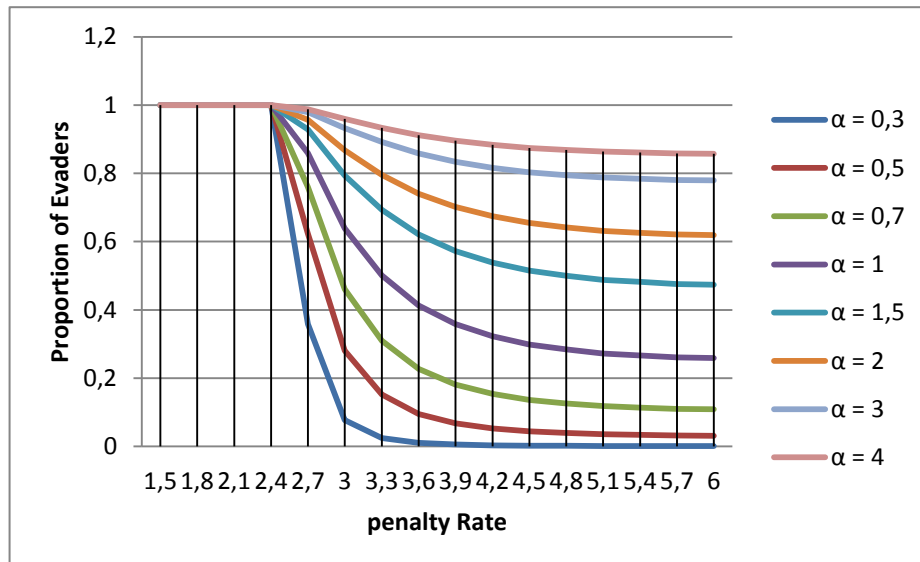


Figure 10: Tax evasion for taxpayers which have different risk parameters for penalty rate



### 5.3 The Effects of Audit Rate on Tax Evasion

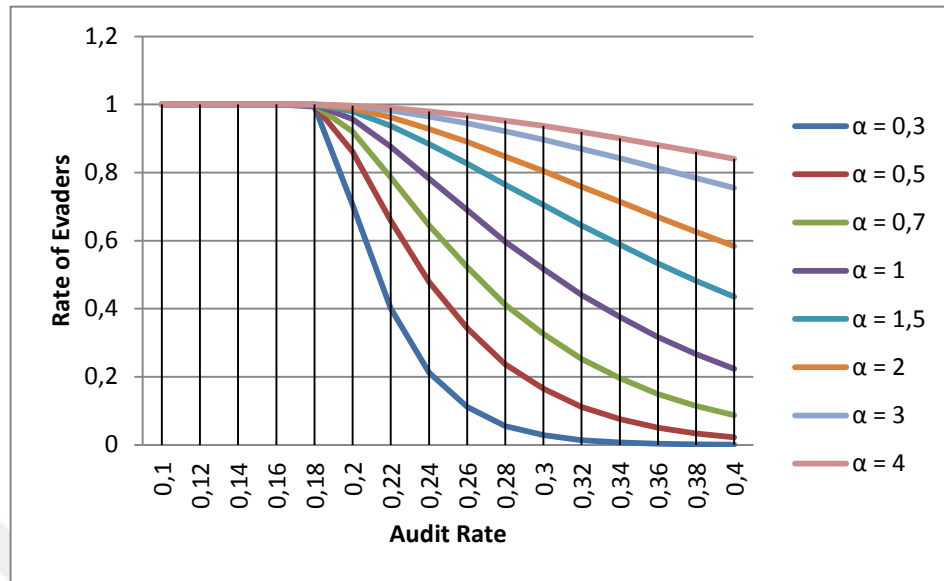


Figure 11: Tax evasion for taxpayers which have different risk parameters for audit rate.

As seen in the Figure 11, as audit rate increases, the rate of evaders and consequently tax evasion decreases. Moreover, as the taxpayers' risk parameter increases, and as seen in the slope of the graphs, decrease in the amount of the rate of evaders has decreased. But if we compare Figure 11 with the previous one, and if we look at the slopes of graphs, the effect of increase in audit rate has a greater effect than increase in penalty rate on tax evasion. And while graphs are convex (from below) for penalty rate, they are concave (from below) for audit rate for risk loving taxpayers but convex (from below) for risk averse taxpayers.

## **CHAPTER 6**

### **CONCLUSION**

In the comparative analysis regarding audit cost of the countries which we made, we found it has no effect on optimum audit rate. Even if the tax rate is high in low penalty rate, up to a certain point we saw that all taxpayers in every risk parameters evaded tax. This shows that higher penalty rate is a greater deterrent than higher tax rate. Therefore, a government, aiming to increase its tax revenue, may increase penalty rate and punish dishonest taxpayers instead of punishing all their citizens unjustly by increasing tax rates. Furthermore, and more importantly, the increase in tax rate compared to increase in penalty rate increases at a lower amount.

In this study, our aim is to research the effects of audit rate on governments' or other tax authorities' tax revenue, but, to test the robustness of our model, we analyzed the effects of tax rate, penalty rate and audit rate on tax evasion, and we found that the increase in penalty rate decreases the rate of evaders, and increase in audit rate also decreases the evasion. But the effect of increase in audit rate has a greater effect than increase in penalty rate on tax evasion.

As a result of our analysis, we also found a constraint that has an impact on the effect of tax rate on tax evasion, in the case of multiplication of audit rate and penalty rate

is less than 1, consistent with the findings of Allingham & Sandmo (1972) and Yitzhaki (1974) the increase in tax rate increases tax evasion, if it is greater than 1, consistent with later researches (Friedland et al., 1978), (Pommerehne & Weck-Hannemann, 1996), the increase in tax rate decreases tax evasion. But interestingly, if it is equal to 1, there is no effect of tax rate on tax evasion. Maybe this constraint is a solution for the Yitzhaki Puzzle.

We used expected utility theory which is a benchmark in this literature, but, the main contribution of this study is to differentiate taxpayers according to their risk parameters, that is, according to their risk taking behaviors. Some studies which could be a solution to the Yitzhaki Puzzle, as mentioned in the chapter 1, we believe that with the inclusion of these techniques, such as Prospect Theory or Advanced Tax Payment System, to our model we may get more realistic results.

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