TOWARDS A THREE-PLAYER GAME MODELIZATION OF CORPORATE TAX EVASION

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Abstract

This paper models corporate tax evasion as a game among three players: tax authorities, shareholders and the manager in order to understand the behavior of corporate tax evasion (CTE), its causes and the possible mechanisms that can alleviate it. For this purpose, a three-level programming is used in order to estimate optimum tax authorities' decision variables that limit the tax evasion. The main finding of this paper is that the existing inequality in penalty rate for tax evasion between shareholders and manager is likely to be related to the bonus rate of tax evasion accorded by shareholders to the manager. Accordingly, this paper recommends that the penalty rate for tax evasion practices must not always be higher for the manager than for shareholders. An alternative tool to limit tax evasion can be considering the probability of tax audit equal to one. Finally, for researchers, this study may serve as model for analyzing taxpayers' behavior in a corporate taxation game.

1. INTRODUCTION

Studying tax compliance and finding ways to reduce it is of great importance to the researchers and policy makers. Indeed, one of the major state interests is that citizens follow the tax-paying duty and behave in compliance with the tax rules (Kirchler et al., 2008). The corporation has the same legal rights and obligations as an individual. However, the specificity of corporate taxation is that a person (the agent) acts and makes decisions on behalf of another person (the principal) (Erhardt et al., 2003).

The principal delegates some tasks to an agent who should react for the principal's best interest. However, the delegation of tasks creates an information asymmetry between the principal and the agent because the latter possesses more relevant information (Ben Abdelaziz et al., 2015). In corporate taxation, there are at least two kinds of information asymmetry: one between the manager and the tax authorities and the other between the manager and the shareholders. Normally, shareholders require the manager to use optimum tax management practices that minimize taxes, net of sanctions (Hanlon and Slemrod, 2009). Nevertheless, having a complete contract that regulates the relation between the principal (shareholders) and the agent (manager) does not seem to be applied. Thus, the agreement is generally achieved without a contract. Tax authorities are also a player in this game that tries to minimize tax management practices. In addition, an important challenge for the government is to limit tax management practices as those practices affect the tax burden distribution fairness and the tax raising costs (Mehran, 1995; Ben Abdelaziz et al., 2015). Note that tax management practices include tax avoidance, accounting manipulation, and legal obfuscation (Mehran, 1995).Thus, analyzing motivations and finding constraints of corporate tax evasion is of great importance.

One of the tools adopted for this purpose was the agent-based modeling. The use of agent-based modeling was found very productive in different areas of the social sciences (Hashimzade et al., 2015) by involving the construction of a set of interactions between agents and environment. In addition, agent-based modeling methodology was used in individual tax evasion literature (Allingham and Sandmo, 1972; Yitzhaki, 1974) as well as in corporate tax evasion literature with the pioneering work of Crocker and Slemrod (2005) and Chen and Chu (2005), who analyzed the relationship between two players: shareholders and the manager. Nevertheless, it seems that none of the previous works succeeded in analyzing those motivations and proposing a satisfactory solution for tax evasion. For this reason, in a tentatively different approach from previous works, we will use this method in order to analyze corporate tax evasion behavior by modeling it using three players: tax authorities, the manager and shareholders. In addition, and as highlighted by Erhardt et al. (2003), the difficulty of studying the behavior of tax evasion is that information about tax evasion behavior is not disclosed in tax return reports and therefore cannot be deduced from those reports (Erhardt et al., 2003).

As a consequence, this study purported to analyze corporate tax evasion as a game among three players: tax authorities, shareholders and the manager. For this purpose, we use a three-level programming in order to propose optimum tax authorities' decision variables that limit tax evasion.

The main findings of this investigation were: firstly, there seemed to be an inequality in penalty rate for tax evasion between shareholders and the manager; secondly, tax evasion was likely to be related to the bonus rate of tax evasion accorded by shareholders to the manager.

Accordingly, the main recommendation of this work was to impose unequal tax evasion penalty rates for the manager and for shareholders. This inequality must be related to the estimated bonus rate of tax evasion accorded by shareholders to the manager.

The remainder of this paper is organized as follows. Section 2 is a review of the literature related to the topic. Section 3 presents the modelization of tax evasion behavior as a three-player game consisting in tax authorities, shareholders and the manager. Section

4 is a description of the equilibrium. Finally, section 5 exhibits the main conclusions and recommendations.

2. LITERATURE REVIEW

Tax compliance studies emphasized the fact that taxpayers are potential criminals. Thus, research studies have focused on preventing crime instead of pursuing tax compliance (Casal and Mittone, 2016).

Tax compliance literature started with the works of Allingham and Sandmo (1972) and Yitzhaki (1974), who modeled the taxpayer as "a *gambler"*. In Allingham and Sandmo's (1972) model, the decision of the taxpayer about the tax evasion level is faced with the risk of evasion detection. This risk is related to the probability of audit conducted by tax authorities. Allingham and Sandmo's (1972) research was considered as an initial framework focusing on how the probability of detection, penalty, tax rates, and tax liability influenced the decision of the taxpayer about tax evasion.

Furthermore, several previous studies have examined the ethical aspects of tax compliance decisions. Hermalin and Weisbach (1991) shared the idea that non-tax compliance behavior was associated with other selfishness behaviors as a conclusion to their investigation of tax non-compliant corporate insiders' use of their informational advantage in trading their firm stocks. These scholars strongly argued that corporate insiders who chose to not comply with the tax law were more prone to ethical misbehavior by using their informational advantage to trade insider stocks before any significant change in stock price. A decade later, Modigliani and Perotti (2000) revisited this issue and confirmed this idea. Similarly, Kaufmann et al. (2000) maintained that general ethical beliefs were good indicators of individuals' collective attitudes toward what was the right and what was the wrong independently of any specific decision. In an analogous study, Gambetta (2000) showed that individuals concerned with maximizing their personal gains at the expense of others were less likely to use tax compliance behavior. More recently, Kallunki et al. (2016) echoed the idea that the tax non-compliance behavior was a signal of lower ethics and higher selfishness behaviors of an individual whose aim was to realize personal gains at the expense of others.

To develop a better understanding of the process of tax non-compliance behavior, researchers attempted to modelize it using the principal-agent model. Indeed, Hermalin and Weisbach (1991) and Erard and Feinstein (1994) discovered that three major assumptions describe the equilibrium in tax compliance game: the perfect information, the representative agents and the rationality of the decision maker. In the same line of thought, Migdalas (2002) found that since the game theory provides mathematical models of cooperation and conflict between the different utility optimizers, its application on tax non-compliance studies was efficient. Using the game theory, Frijns et al. (2016) modeled tax non-compliance between two players: the social planner (the principal) and individuals (agents). These scholars observed that the "*social planner*" collected taxes and redistributed a percentage of the tax collected in the aim to reduce the inequality. Moreover, the "*social planner*" fixed the auditing system power and tax evasion penalty. Frijns et al. (2016) argued that the government was interested in preventing tax evasion by choosing randomly audited individuals.

In another recent work, Casal and Mittone (2016) also used experimental methods in tax compliance studies and tested the role of different non-monetary incentives on tax compliance. They found that a negative non-monetary incentive was more effective in increasing tax compliance than a positive non-monetary incentive. Moreover, they showed that when evasion is disclosed to the public, tax evaders were willing to pay in order to keep their dishonest behavior undisclosed and to avoid public shame.

Using a principal-agent model, Hashimzade et al. (2014) investigated the best audit strategy response of the tax administration in the presence of heterogeneous taxpayers, imperfect information and evolutionary survival of the taxpayers. That study showed that the best response of tax administration could not be a well-defined function. It should be an adaptive learning approach instead. This recommendation was in line with Core et al.'s

(1999) proposal and in total agreement with the OECD tax administration actual practice of "*predictive analytics*".

Unlike the individual risk aversion, corporate shareholders have diversified portfolios and should be, relatively, risk neutral (Brown, 2008). Corporate tax evasion was examined by Chen and Chu (2005) and Crocker and Slemrod (2005). These scholars argued that corporate tax evasion was a form of contractual relationship between the shareholders and the Chief Financial Officer (CFO), which determined the deductions from taxable corporate income. The study by Crocker and Slemrod (2005) examined corporate tax evasion in the presence of a contractual relationship between the shareholders and the Chief Financial Officer (CFO), which determines the deductions from taxable corporate income. Crocker and Slemrod (2005) claimed that if the implementation of the two penalties is constant and equal to the marginal social costs, then their results called for using only the penalty of the agent. If they have equal cost functions, the results call for using both penalties, with more agent penalties.

Thus, Crocker and Slemrod 's (2005) study demonstrated that a firm's principal could adjust compensation contracts with the agents to encourage the manager using tax evasion on his behalf. Therefore, the study opted for the sanctions imposed directly on the CFO considering them more effective to reduce evasion than those imposed on shareholders (Crocker and Slemrod, 2005). This study was dismissed because of its normative implications on the policy enforcement targeting the tax evasion.

Chen and Chu (2005) modeled corporate tax evasion as a contract between a risk-neutral company owners and observed that the risk agent was responsible for tax reporting. Chen and Chu (2005) argued that corporate tax evasion involves the tradeoff between the loss of effectiveness of internal control and the expected gain from evasion. In their model, the incomplete contract resulted from the illegal nature of tax evasion. In an effective contract, it is essential to share risks between shareholders and managers through paying a higher wage when the illegal tax evasion is detected. However, such a contract would be virtually impossible to enforce, as the court should not honor a contract based on illegal activities (Brown, 2008).

Desai and Dharmapala (2006) reported that agent high-powered incentives were not beneficial to the principal if tax evasion and rent diversion were complementary activities. The results of Desai and Dharmapala (2006) showed a negative relationship between incentive compensation and tax aggressiveness in firms with poor corporate governance structure.

Using audit data, Zheng et al. (2012) found that increased tax non-compliance was associated with strong executive compensation incentives. They suggested that corporate tax non-compliance was U-shaped: meaning to be high among small businesses; dropping among medium-sized firms and then increasing among large firms.

Neifar et al. (2016) concluded that corruption norms represented a challenge when limiting corporate tax evasion as firms with a higher corruption norm were less likely to react to an increase in any enforcement activities.

In conclusion, despite the fact that the behavioral approach to tax evasion viewed tax evasion as a decision made through a rationalization of costs and benefits (Erhardt et al., 2003), it was also viewed as a corporate social responsibility (Mehran, 1995). Furthermore, tax non-compliance was considered through the lens of ethics and morality (Christensen and Murphy, 2004; and Brown et al., 2011). Because of all these considerations, tax evasion remains a very complex economic, social and moral problem. It deserves more serious attention from researchers in order to alleviate its impact. Consequently, this work will attempt to contribute to existing efforts and investigate this issue through the proposition of a novel approach which models corporate tax evasion as a game involving three players: tax authorities, shareholders and the manager.

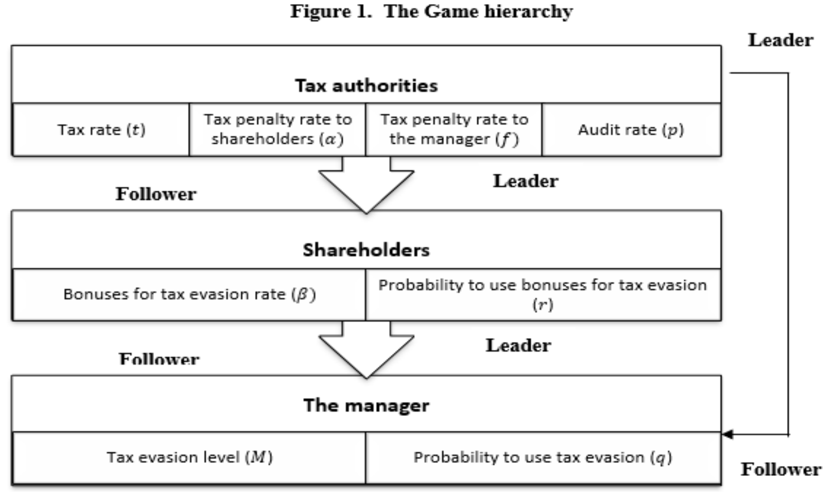
3. THE MODEL

3.1.Model description

Our model departs from the existing literature that has tried to model tax evasion as a principal-agent relationship. However, in our game, and in contrast with the prevailing idea, we will consider three players: tax authorities, shareholders and the manager. In addition, in our game model, we follow the idea of Fukofuka (2013) and we consider that the manager is responsible for the tax evasion decision.

Figure 1 describes the structure of our game.

Figure 1. The Game hierarchy



3.1.1. Relationship between tax authorities and the owners (shareholders). In line with Brick et al. (2006) and Balle et al. (2015), who studied the principal-agent framework in a game between tax authorities and the taxpayer, we develop the relationship between tax authorities and shareholders .

In our game, we assume when tax evasion is detected by tax authorities, shareholders will support the penalty, which is proportioned to the amount of tax evasion (αM); whereα is the penalty rate for shareholders in case of tax evasion detection; and$M$ is the amount of tax evasion.

Tax authorities are responsible for the tax rate$t \in [0.1]$; the probability of tax audit $p \in [0.1]$; and the penalty rate of tax evasion for shareholders a.

3.1.2. Relationship between shareholders and the manager. The shareholders try to minimize their expected payment to the manager, while also trying to motivate the manager to make decisions that maximize shareholders' benefits by using optimal tax management methods.

Tax authorities ask the taxpayer to report his or her income and then assess the reported income to determine its truthfulness. However, the specificity of corporate tax evasion is that the tax evasion decision is made by the manager on behalf of the shareholders.

In this paper, we suppose that shareholders are risk neutral and offer "*a take it or leave it*" wage contract to the manager, who is supposed to be risk averse. Shareholders can offer in addition to the wage, bonuses for tax evasion practices with probability (r) in order to motivate the manager to choose "*optimal*" tax minimization practices.

The total compensation is $T = r\,(S + \beta M) + (1 - r)(S)$; then $T = S + r * \beta * M$.

With:

$T =$ Total compensation received by the manager.

$S =$ Manager's fixed salary.

$M =$Tax evasion with $M = 0$ if the manager does not resort to tax evasion, which means that the reported taxable income is equal to real taxable income; M$\neq$ 0 if not.

β =Bonuses rate for tax evasion.

r =The probability that shareholders use bonuses for tax evasion strategy.

3.1.3. Relationship between tax authorities and the manager. In corporate taxation, the manager is responsible for taxable income reporting. Then, the manager has two major alternatives: reporting the real taxable income to the tax authorities $(w = x)$ with probability $(1 - q)$ or using tax evasion strategy with probability (q) $(w<x)$. Once the manager communicates the statement, the tax authorities may accept the disclosed tax with probability $(1 - p)$ or decide to conduct an audit with probability (p).

In Meyer-Brauns' (2013) and Erhardt et al's (2003) studies, only shareholders assume a tax penalty in case of detection of tax evasion. However, and as emphasized by Crocker and Slemrod (2005), in order to limit corporate tax evasion, the manager should also be penalized. This penalty can take the form of a fine that is proportional to the amount of the illegal tax evasion as in the Hanlon and Slemrod (2009) study. In this paper, we suppose that the manager can assume in case of tax audit (p) a penalty that is proportional to the amount of the tax evasion (penalty $= f * M$).

In total agreement with Ronen and Yaari (2007) who investigated the earnings management game, we determine the timeline of our game as follows:

Date 1: tax authorities determine the tax rate and the tax audit probability $t, p \in [0.1]$respectively and the penalties rates of tax evasion for shareholders and the manager $a\, and f > 0$ respectively.

Date 2: Shareholders design the wage contract with the manager$T = S + r * \beta * M$with S; the fixed salary $r \in [0.1]$ is the probability to use bonuses for tax evasion strategy; $\beta \in [0.1]$is the bonus rate to tax evasion.

Date 3: the manager observes the true taxable income *x*.

Date 4: the manager decides or not to use tax evasion $(w < x)$ with probability (q).

Date 5: tax authorities decide to conduct an audit with probability p.

Date 6: the shareholders and the manager pay tax penalties in case of detection of tax evasion by tax authorities.

Date 7: end of the period.

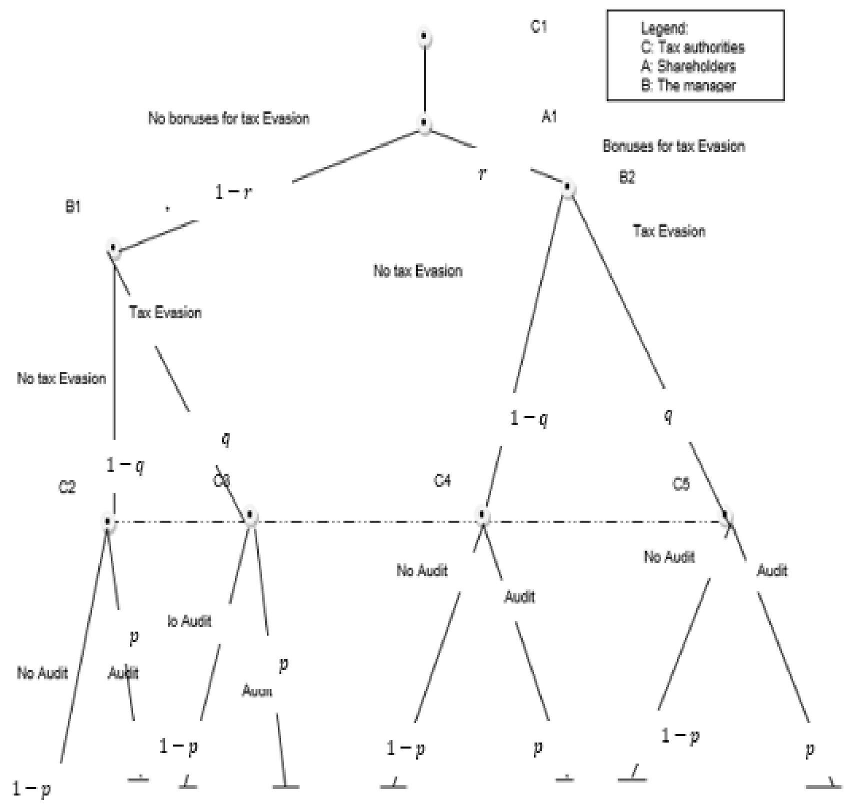
4. The Game Tree

In this section, we design a game tree of tax evasion between the three players: tax authorities, shareholders and the manager.

In our game, tax authorities are the first who make decisions about the tax rate (t) and tax evasion penalty rate for shareholders and manager (respectively $\alpha\ and\ f$) and the probability of tax audit (p). Then, shareholders decide to offer bonuses for tax evasion activities to the manager with probability (r) or no with probability $(1-r)$. Then, the manager has to decide to use tax evasion with probability (q) or not to use tax evasion practices with probability $(1-q)$.

Figure 2 presents our game tree.

Figure 1. Corporate tax evasion game tree



The different expected utility functions of our three-player game in each node are summarized in table 1.

Table 1. Players expected utility functions in each node

Node	Tax authorities	Shareholders	The manager
C2: No bonuses |no tax evasion| no audit	$E(taxauthorities) = t * x$	$E(shareholders) = 0$	$E(Manager) = S$
C2: No bonuses |no tax evasion| audit	$E(taxauthorities) = t * x - C(p)$	$E(shareholders) = 0$	$E(Manager) = S$
C3: No bonuses | tax evasion| No audit	$E(tax\ authorities) = t * (x - M)$	$E(shareholders) = M$	$E(Manager) = S$
C3: No bonuses | tax evasion| audit	$E(tax\ authorities) = tx - C(p) + f * M + \alpha * M$	$E(shareholders) = -\alpha * M$	$E(Manager) = S - (f \times M)$
C4: Bonuses |no tax evasion| no audit	$E(taxauthorities = t * x$	$E(shareholders) = 0$	$E(Manager) = S$
C4: Bonuses |no tax evasion| audit	$E(taxauthorities) = t * x - C(p)$	$E(shareholders) = 0$	$E(Manager) = S$
C5: Bonuses | tax evasion| no audit	$E(tax\ authorities) = t * (x - M)$	$E(shareholders) = M - \beta M$	$E(Manager) = S + \beta * M$
C5: Bonuses | tax evasion| audit	$E(taxauthorities) = t * (x - M) + t * M - C(p) + f * M + \alpha * M$	$E(shareholders) = -\beta * M - \alpha * M$	$E(Manager) = S + \beta * M - (f \times M)$

5. The Optimization Models

In this section, we will develop our optimization models based on figure 2 and table 1. Our game involves three players: tax authorities, shareholders and the manager. Each player in our game has his own decision variables and objective function. Shareholders and the manager have full authority to decide how to optimize their objective function in view of the decisions of tax authorities as in a Stackelberg model situation with three levels.

The decision variables of tax authorities are the tax (t), the probability to conduct a tax audit, which is equal to the probability to detect it (p) and the tax penalty rate to the manager and shareholders ($f\ and\ \alpha\ respectively$).

The decision variables of shareholders are the bonuses for tax evasion rate (β) and the probability to use bonuses for tax evasion (r). The decision variables of the manager are the level of tax evasion (M) and the probability to use tax evasion strategy (q).

Therefore, we write the different expected utility functions of our game players as follows:

$$E(tax - authorities) = (1-r)*(1-q)*(1-p)*(\,t*x) + (1-r)*(1-q)*p*(\,t*x - C(p)) + (1-r)*q*(1-p)*(t*(x-M)\,) + (1-r)*q*p*(\,t\,x - C(p) + f*M + \alpha*M) + r*(1-q)*(1-p)*\ (t*x\,) + r*(1-q)*p*(\,t*x-\ C(p)) + r*q*(1-p)*(t*(x-M)\,) + r*q*p*(\,t*(x-M) + t*M-\ C(p) +\ f*M + \alpha*M)$$

$$E(Shareholders) = (1-r)*(1-q)*(1-p)*0 + (1-r)*(1-q)*p*0 + (1-r)*q*(1-p)*M + (1-r)*q*p*(-\alpha*M) + r*(1-q)*(1-p)*0 + r*(1-q)*p*0 + r*q*(1-p)*(M-\beta M\,) + r*p*q*(-\,\beta*M - \alpha*M)$$

$$E(Manager) = (1-r)*(1-q)*(1-p)*S + (1-r)*(1-q)*p*S + (1-r)*q*(1-p)*S + (1-r)*q*p*(\,S-(f\times M)) + r*(1-q)*(1-p)*S + r*(1-q)*p*S + r*q*(1-p)*(\,S+\beta*M) + r*q*p*(\,S+\beta*M-(f\times M))$$

We assume that the cost of tax audit $C(p)$ is equal to $c * p$.

Then by replacing $C(p)$ by $c * p$ and simplifying we obtain the expected tax authorities function as follows:

$$E(tax - authorities) = tx + fMpq + Mq\left((-1 + p)t + p * \alpha\right) - cp^2 \quad (1)$$

$$E(Shareholders) = -M\,q\,(-1 + r * \beta + p\,(1 + \alpha)) \quad (2)$$

$$E(Manager) = S + M * q * (r * \beta - f * p) \quad (3)$$

In order to write our optimization programs, we must find conditions that prevent the manager from using tax evasion and shareholders from offering bonuses for tax evasion.

In order to do so, we subdivide our game in sub-games in order to find conditions for this scenario.

At the Node, A1, Shareholders offer a wage to the manager as follows:

$$T = S + \beta M$$

The reported taxable income is observed only by the manager and either can represent the real taxable income or not$(w = x - M)$ with x is the real taxable income, M is the total amount of tax evasion(M).

Table 2 describes the normal form of the sub-game between shareholders and the manager.

Table 2. The normal form of the sub-game between shareholders and the manager

		Shareholders	
		No Bonuses for tax evasion $\mathbf{1-r}$ $T = S$	**Bonuses for tax evasion** $\boldsymbol{r}$ $T = S + \beta(M)$
Manager	**Use tax evasion** $\boldsymbol{q}$	$p * \left(S - (f \times M)\right) + (1 - p) * S$; $p * (-\alpha * M) + (1 - p) * M$	$p * \left(S + \beta * M - (f \times M)\right) + (1 - p) * (S + \beta * M)$; $p * (-\beta * M - \alpha * M) + (1 - p) * (M - \beta M)$
	Do not use tax evasion $\mathbf{1-q}$	S; 0	S; 0

For the manager, in the case when shareholders choose to not offer bonuses for tax evasion, (do not use tax evasion |*) is always more relevant than the strategy (use tax evasion |*) as $f * M * p > 0$.

When shareholders choose to offer bonuses for tax evasion, for the manager the strategy (use tax evasion *|) is more relevant than the strategy (do not use tax evasion |*) if $\beta > f * p$ **(1)**

Condition 1: the strategy (do not use tax evasion | bonuses for tax evasion) is more relevant than the strategy (use tax evasion | bonuses for tax evasion) for the manager if the costs of tax evasion detection are greater than benefits of tax evasion.

$\beta < f * p$ (F1)

For shareholders, when the manager chooses to use tax evasion, the strategy (*| no bonuses for tax evasion) is more relevant than the strategy (*| bonuses for tax evasion) if: $\beta \times (M) > 0$ which is always true.

When the manager chooses to not use tax evasion, neither *|bonuses for tax evasion nor *| no bonuses for tax evasion is of concern to shareholders.

Let us estimate the more relevant combination between:

1: (No bonuses for tax evasion| do not use tax evasion) and,

2: (bonuses for tax evasion| use tax evasion).

The expected utility function of both manager and shareholders in the combination N°1 can be written as follows:

$$E\ (Manager)1 = S$$
$$E\ (Shareholders)1 = 0$$

The expected utility function of both manager and shareholders in the combination N°2 can be written as follows:

$$E\ (Manager)2 = p * \left(S + \beta * M - (f \times M)\right) + (1 - p) * (S + \beta * M)$$

$$E\ (Shareholders)2 = p * (-\beta * M - \alpha * M) + (1 - p) * (M - \beta M)$$

The strategy (No bonuses for tax evasion| do not use tax evasion) is more dominant than the strategy (bonuses for tax evasion| use tax evasion) if the two following conditions are verified:

$$\begin{cases} \beta - f * p < 0 & (\mathbf{F1}) \\ (1 - p(1 + \alpha) - \beta) < 0 & (\mathbf{F2}) \end{cases}$$

We duplicated the same work in other nodes (see appendix 1) and we found that the best strategy of tax authorities was to modify their own decision variables and lead $\beta(f)$***(F3)***. In addition, by doing so, the manager will choose to not use tax evasion.

Therefore, in order to find the equilibrium, we must estimate the optimum probability of tax audit (p), the optimum shareholders tax penalty rate (α) and the optimum manager tax penalty rate (f) that lead the following constraint to hold:

$$\beta - f * p < 0 \qquad \textbf{(F1)}$$

$$(1 - p(1 + \alpha) - \beta) < 0 \qquad \textbf{(F2)}$$

6. The equilibrium

As shown in section 5, above the different players' functions are as follows:

Tax authorities program (level 1- leader) (decision variables: $t,\ f, \alpha, p$**)**

$$MaxA = tx + fMpq + Mq\big((-1 + p)t + p * \alpha\big) - cp^2$$

Shareholders program (level 2- follower) (decision variables: β, r**)**

$$Max\ B = -M\ q\ (-1 + r * \beta + p\ (1 + \alpha))$$

The manager program (level 3) (decision variables: q, M**)**

$$Max\ C = S + M *\ q * (r *\ \beta - f * p)$$

Under the following constraints:

$$\beta - f * p < 0$$

$$(1 - p(1 + \alpha) - \beta) < 0$$

$$0 \leq \beta, t, p, q, r \leq 1; \alpha, f > 0$$

We use Mathematica to resolve the previous problem.

Table 3. Results

Players	Mathematica output
Tax authorities	$t = \frac{2cMq + M^2q^2 - 2cx}{M^2q^2}$ $\alpha = \frac{x - Mq\beta}{Mq - x}$ $f = \frac{Mq\beta}{Mq - x}$ $p = \frac{Mq - x}{Mq}$
Shareholders	$\beta = 0$ $r = 1$
The manager	$M = 0$ $q = 0$
With: $t = tax\ rate$ $c = cost\ rate\ of\ tax\ audit$ p=probability to conduct a tax audit $M = tax\ evasion$ $q = probability\ for\ using\ tax\ evasion$ $x = real\ taxable\ income$ $r = probability\ that\ shareholders\ dont\ \ use\ bonuses\ for\ tax\ evasion$ $f = penalty\ rate\ for\ tax\ evasion\ to\ shareholder,$ $\alpha = penalty\ rate\ for\ tax\ evasion\ to\ the\ manager$ $\beta = bonuses\ for\ tax\ evasion\ rate$	

The Mathematica output showed that, mathematically, there exists a solution that leads the manager not to use tax evasion and shareholders not to use bonuses for tax evasion.

We found that the optimum tax rate able to limit tax evasion behavior was $t = \frac{2cMq+M^2q^2-2cx}{M^2q^2}$. We also found that the probability to conduct a tax audit p must be as follows: $p = \frac{Mq-x}{Mq}$.

Moreover, we found that the penalty rate for tax evasion to shareholder f must be as follows: $f = \frac{Mq\beta}{Mq-x}$; and the penalty rate for tax evasion to the manager was α which was equal to $\alpha = \frac{x-Mq\beta}{Mq-x}$.

We found that, if $\beta \in [0, \frac{x}{2Mq}]$, tax authorities must design a penalty rate for shareholders greater than the penalty rate for the manager $f > \alpha$. If $\beta \in [\frac{x}{2Mq}, 1]$, tax authorities must design a penalty rate for the manager greater than the penalty rate for shareholders $f < \alpha$ (see appendix 2). Thus, our findings differed from Crocker and Slemrod's (2005) which showed that the sanctions imposed directly on the CFO were more effective to reduce evasion than those imposed on shareholders.

7. Conclusion

In this paper, we applied a game theoretic approach to model corporate tax evasion involving three players: tax authorities, shareholders and the manager. We used three-level programming to find the equilibrium solution.

Our results show that we can limit tax evasion practices by managing a penalty policy. We proved that the penalty rate for tax evasion would vary according to the estimated bonus rate for tax evasion proposed by shareholders to the manager.

We contributed to the existing studies on tax evasion by applying game theory involving three players using three-level programming to propose a solution. Our finding differ with the Crocker and Slemrod's (2005) results and demonstrate that the penalty rate for tax evasion practices depends on the bonus rate.

As far as regulators are concerned, this paper can be used to adjust penalty policies. In addition, these findings reveal that in the case of periodic tax audit practices, as in the German case, tax evasion practices will be avoided. Eventually, this work can find good applications in accounting and tax studies as it analyzes taxpayer behavior in a corporate taxing game.

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Appendix

Appendix 1

At the level of node B2, our game involves two players, one moving first (the manager) by sending a message about reporting taxes, which condition the second player's action (tax authorities) who decide to accept the amount of tax or conduct an audit. This game, as in Wane (2000), belongs to the signaling games class. The manager (sender) forwards a message (the tax statement) to the tax authorities (the receiver) whose strategy (conduct an audit or not) depends on this disclosed information.

Note that in some countries, like Germany, where audits are conducted periodically, then the dominant strategy is to not use tax evasion if $\beta < p2 * f$.

Table 4 describes the sub-game in a normal form.

Table 4. Normal form of the sub-game between the manager and tax authorities (Node B2)

		Tax authorities	
		Conduct Audit $\boldsymbol{p}$	**Don't Conduct Audit** $\boldsymbol{1-p}$
Manager	**Use tax evasion** $\boldsymbol{q}$	$S+\beta\times(M)-(f\times M)$; $tx+\alpha M+(f\times M)+\alpha*M-c*p$	$S+\beta\times(M)$; $t\times(x-M)$
	Don't use tax evasion $\boldsymbol{1-q}$	S; $(t\times x)-C(p)$	S; $t\times x$

For the manager, the situation (use tax evasion| do not conduct audit) is always more relevant than the situation (use tax evasion| conduct audit) as $(f\times M)>0$ is always true.

For the manager, the strategy (do not use tax evasion) is more relevant than the strategy (use tax evasion| Conduct audit) if the compensation rate of tax evasion by shareholders is more than the penalty rate of tax evasion by tax authorities:

$$\beta\times(M)-(f\times M)<0$$
$$\beta\times(M)<(f\times M)$$

Condition 3: the strategy (do not use tax evasion) is more dominant than the strategy (use tax evasion | conduct audit) for the manager if costs of tax evasion detection are greater than the benefits of tax evasion:

$\beta\times(M)<(f\times M)$**(F3)**

In case when there is no audit; the strategy (use tax evasion| *) for the manager is more relevant than the strategy (do not use tax evasion) as:

$S + \beta \times (M) \leftrightarrow \beta \times (M) > S$ Always true.

For tax authorities, the strategy (*, Conduct audit) is more dominant than the strategy (* | do not conduct audit) if:

$$t \times (x - M) + tM + (f \times M) - c * p > t \times (x - M)$$
$$\leftrightarrow tM + (f \times M) - c * p > 0$$

Condition 4: the strategy (, Conduct audit) is more dominant than the strategy (* | do not conduct audit) to tax authorities if the costs of conducting and audit and detecting the tax evasion are more relevant than the benefits of tax evasion*

$M\,(t + f) - c * p > 0$ **(F4)**

The strategy (use tax evasion| conduct audit) is more relevant than the strategy (do not use tax evasion| conduct audit) as:

$$t \times (x - M) + tM + (f \times M) - c * p > t \times x - c * p$$
$$\leftrightarrow -tM + tM + (f \times M) > 0$$

$\leftrightarrow (f \times M) > 0$ is always true.

The strategy (do not use tax evasion| conduct audit) is always more relevant than the strategy (use tax evasion| do not conduct audit) as $t \times x > t \times (x - M)$.

Normally, as tax authorities are the main leader in this game, they must ensure that F3 hold and F4 not hold in order to have the strategy (do not use tax evasion | do not conduct the audit) as non-dominated strategy.

Appendix 2

We will estimate if tax authorities must choose penalty rate for shareholders greater than the penalty rate of the manager or not.

Tax authorities will choose penalty rate for shareholders greater than the penalty rate for the manager if:

$$\frac{Mq\beta}{Mq - x} > \frac{x - Mq\beta}{Mq - x} \leftrightarrow$$
$$\left(\frac{Mq\beta}{Mq - x}\right) - \left(\frac{x - Mq\beta}{Mq - x}\right) > 0$$

$$-(x - 2\,Mq\beta)/(Mq - x) > 0$$
$$-(x - 2\,Mq\beta)/(Mq - x) > 0$$
$$\beta < \frac{x}{2Mq}$$

References

Allingham, M. & Sandmo, A. 1972. Income Tax Evasion: A Theoretical Analysis *Journal Of Public Economics,* 1**,** 323 –338.

Ben Abdelaziz, F., Neifar, S. & De Bourmont, M. 2015. Auditing And Game Theory: A Survey. *Multiple Criteria Decision Making In Finance, Insurance And Investment, Multiple Criteria Decision Making*.Springer Series .

Brick, I. E., Palmon, O. & Wald, J. K. 2006. Ceo Compensation, Director Compensation, And Firm Performance: Evidence Of Cronyism? *Journal Of Corporate Finance,* 12**,** 403-423.

Brown, E., Cloke, J. & Christensen, J. 2011. The Looting Continues: Tax Havens And Corruption. *Critical Perspectives On International Business,* 7**,** 177-196.

Brown, J. R. 2008. *The Spread Of Aggressive Corporate Tax Reporting: A Detailed Examination Of The Corporate-Owned Life Insurance Shelter* P.H.D, The University Of Texas At Austin.

Chen, K. & Chu, C. 2005. Internal Control Vs. External Manipulation: A Model Of Corporate Income Tax Evasion *Rand Journal Of Economics,* 38**,** 151-164.

Christensen, J. & Murphy, R. 2004. The Social Irresponsibility Of Corporate Tax Avoidance: Taking Csr To The Bottom Line. *Development,* 47**,** 37-44.

Core, J. E., Holthausen, R. W. & Larcker, D. F. 1999. Corporate Governance, Chief Executive Officer Compensation, And Firm Performance. *Journal Of Financial Economics,* 51**,** 371-406.

Crocker, K. & Slemrod, J. 2005. Corporate Tax Evasion With Agency Costs. *Journal Of Public Economics,* 89.

Desai, M. & Dharmapala, D. 2006. Corporate Tax Avoidance And High-Powered Incentives. *Journal Of Financial Economics,* 79.

Erard, B. & Feinstein, J. S. 1994. Honesty And Evasion In The Tax Compliance Game. *The Rand Journal Of Economics***,** 1-19.

Erhardt, N. L., Werbel, J. D. & Shrader, C. B. 2003. Board Of Director Diversity And Firm Financial Performance. *Corporate Governance: An International Review,* 11**,** 102-111.

Frank, M. M., Lynch, L. J., Rego, S. O. & Zhao, R. 2011. Are Aggressive Reporting Practices Indicative Of An Aggressive Corporate Culture? . *In:*Http://Ssrn.Com/Abstract=1066846 (Ed.).

Frijns, B., Dodd, O. & Cimerova, H. 2016. The Impact Of Cultural Diversity In Corporate Boards On Firm Performance. *Journal Of Corporate Finance*.

Gambetta, D. 2000. Mafia: The Price Of Distrust. *Trust: Making And Breaking Cooperative Relations***,** 158-75.

Hanlon, M. & Slemrod, J. 2009. What Does Tax Aggressiveness Signal? Evidence From Stock Price Reactions To News About Tax Shelter Involvement. *Journal Of Public Economics,* 93**,** 126–141.

Hashimzade, N., Myles, G. D., Page, F. & Rablen, M. D. 2014. Social Networks And Occupational Choice: The Endogenous Formation Of Attitudes And Beliefs About Tax Compliance. *Journal Of Economic Psychology,* 40**,** 134-146.

Hermalin, B. E. & Weisbach, M. S. 1991. The Effects Of Board Composition And Direct Incentives On Firm Performance. *Financial Management***,** 101-112.

Kaufmann, D., Hellman, J. S., Jones, G. & Schankerman, M. A. 2000. Measuring Governance, Corruption, And State Capture: How Firms And Bureaucrats Shape The Business Environment In Transition Economies. *World Bank Policy Research Working Paper*.

Kirchler, E., Hoelzl, E. & Wahl, I. 2008. Enforced Versus Voluntary Tax Compliance: The "Slippery Slope" Framework. *Journal Of Economic Psychology,* 29**,** 210-225.

Mehran, H. 1995. Executive Compensation Structure, Ownership, And Firm Performance. *Journal Of Financial Economics,* 38**,** 163-184.

Meyer-Brauns , P. 2013. Multitasking In Corporate Tax Evasion. Http://Ssrn.Com/Abstract=2331969: Working Paper Of The Max Planck Institute For Tax Law And Public Finance No. 2013-05

Migdalas, A. 2002. Applications Of Game Theory In Finance And Managerial Accounting. *Operational Research*, 2**,** 209-241.

Modigliani, F. & Perotti, E. 2000. Security Markets Versus Bank Finance: Legal Enforcement And Investors' Protection. *International Review Of Finance,* 1**,** 81-96.

Neifar, S., Halioui, K., Ben Abdelaziz, F. 2016. The Motivations Of Earnings Management And Financial Aggressiveness In American Firms Listed On The Nasdaq 100. *Journal Of Applied Accounting Research,* 17.

Ronen, J. & Yaari, V. 2007. Demand For The Truth In Principal–Agent Relationships. *Review Accounting Studies***,** 125–153.

Wane, W. 2000. Tax Evasion, Corruption, And The Remuneration Of Heterogeneous Inspectors. *World Bank Policy Research Working Paper*.

Yitzhaki, S. 1974. A Note On Income Tax Evasion: A Theoretical Analysis. *Journal Of Public Economics*, 3**,** 201 -202.

Zheng, X., El Ghoul, S., Guedhami, O. & Kwok, C. C. 2012. National Culture And Corporate Debt Maturity. *Journal Of Banking & Finance,* 36**,** 468-488.