Tax evasion as a determinant of corruption: a game-theoretical analysis

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TAX EVASION AS A DETERMINANT OF CORRUPTION: A GAME-THEORETICAL ANALYSIS

Abstract

We consider a static non-cooperative game theoretic model of tax evasion. Some concepts concerned with strategies of interaction between economic agents are formalized in order to determine further possible presence of corrupt practices.

Keywords: tax evasion, game theory, corruption, behavior

Introduction

Tax evasion problem, resulting in reduction of tax revenue, is widespread in the world, especially in developing and emerging economies which results in. Its scope determines a variety of tax evasion tools, where the bribes to tax officials are in the front rank. This necessitates an effective detecting of tax evaders in order to do not affect fair taxpayers.

Our research provides the development of static non-cooperative non-zero sum game model in order to determine strategies of interaction between taxpayers and tax official.

The application of game-theoretic tools to solve the problem of tax evasion first was made by M. Alligham & A. Sandmo (1972); they proposed a simple basic model of interaction between taxpayer and tax inspector. Hereafter, J. Macrae (1982), S. Rose-Ackerman (1975), B. Singh (1976), T. Srinivasan (1973) analyzed principal general equilibrium effects and problems of optimization of correlation between identifying tax violation and amounts of penalties, and also application of those penalties to struggle with tax evasion and corruption. Asymmetric penalties and their role in fighting corruption were examined in J. Lambsdorff & M. Nell (2007).

J. Andvig & K. Moene (1990) modeled corruption as a multiplayer coordination game in which supervisors can choose betwe en a bribery and honest strategy. Impact of quantity of information, available to the players (modeled by changing the degree of uncertainty) on corrupt behavior was investigated by S. Berninghaus et al. (2013).

Mechanism of the bribery behavior based on the non-cooperative static game theory, notably in two- and three-level control systems was investigated by S. Lianju & P. Luyan (2011) and by A. Antonenko et al. (2012). Theoretical problem of intermediation in corrupt transactions using game-theory tolls was studied by G. Bayar (2009, 2014), while M. Drugov et al. (2014) made an empirical estimation of intermediation in such transactions.

Bribery transactions in different economic processes were investigated by I. Mostipan (2010) for bribes in traffic police, R. Cerqueti & R. Coppier (2010) analyzed interactions between polluting firms, tax inspectors and politicians in environmental policy making, P. Mauro (1995) provided an empirical assessment of impact of corruption on economic growth, N. Campos et al. (2010) studied impact of corruption on market access for manufacturing companies.

But the autonomous analysis of tax evasion problem does not give the exhaustive information about reduction of tax revenue. Insufficiently fulfilled budget often takes place not because the agents do not pay taxes and do not declare their revenues (or another tax base), but because of complexity of identifying the unfairness of their behavior. Such situation can lead to certain problems for economy, notably to corruption and shadow sector growth, to capital flight and reducing of foreign investment as well.

Thus, the important factor, which determines the actions of all interacting parties in tax evasion model, is the detection probability of unfair acts of taxpayer, and also the possibility of erroneously identified tax violation (in absence of tax evasion or bribes). In this context our model introduces the possibility of recognition the "fair" taxpayer as a tax evading person as well as traditional unsecured detection of taxpayers' tax evasion by tax inspector.

Methodology

In our study, we assumed a common situation of interaction between taxpayer and tax inspector where:

is a perfect demand elasticity for firms' production (i.e. the producers do not shift their on consumers);

taxpayers are bounded rational in their actions, i.e. they try to maximize their revenues, irrespective to means of objective achievement, taking the decisions concerning tax evasion and bribes according to their awareness.

motives of behavior are invariable for all economic agents.

According to fact, that the tax payment supposes the interaction between taxpayers and tax officials, whose objectives and interests do not coincide, we presented this process as the following two player game (1-5):

$$\Gamma\left(\Pr, Ag, G(\Pr, Ag), H(\Pr, Ag)\right), \tag{1}$$

where

$$\Pr = \begin{pmatrix} pr_0 \\ pr_1 \end{pmatrix} \tag{2}$$

– set of tax official's strategies, pr_0 – to make an inspection of taxpayer; pr_1 – do not make an inspection of taxpayer;

$$Ag = (ag_0; \quad ag_1) \tag{3}$$

– set of taxpayer's strategies, ag_0 – to evade tax; ag_1 – do not evade tax;

$$G(\Pr, Ag) = (g_{ij}) = \begin{pmatrix} 0; & \tau R \\ p(\pi)(\tau R + \gamma(\tau R)) - \pi; & (1-q(\pi))\tau R + q(\pi)(2\tau R + \gamma(\tau R)) - \pi \end{pmatrix} =$$

$$= \begin{pmatrix} 0; & \tau R \\ p(\pi)(\tau R + \gamma(\tau R)) - \pi; & \tau R + q(\pi)(\tau R + \gamma(\tau R)) - \pi \end{pmatrix} \tag{4}$$

– tax official's payoff matrix,

$$H(\Pr, Ag) = (h_{ij}) = \begin{pmatrix} R; & (1-\tau)R \\ R - p(\pi)(\tau R + \gamma(\tau R)); & (1-q(\pi))(1-\tau)R + q(\pi)\left(R - (2\tau R + \gamma(\tau R))\right) \end{pmatrix} =$$

$$= \begin{pmatrix} R; & (1-\tau)R \\ R - p(\pi)(\tau R + \gamma(\tau R)); & R - \tau R - q(\pi)(\tau R + \gamma(\tau R)) \end{pmatrix} \tag{5}$$

– taxpayer's payoff matrix.

Thus, the game (1-5) describes the interaction of two agents: tax official and taxpayer; each of them has two pure strategies of behavior. The variables of game are divided into the control parameters of government (τ, γ), the control parameters of tax official (π) and the parameters (and functions) of environment (R, p, q).

In comparison with the classical models and their extensions, our payoff functions (1-5) contain the “transparency” functions of interactions between players, p and q. Those functions are the environment parameters, which mean that they are not the part of tax official’s or taxpayer’s. I.e. tax official and taxpayer cannot change voluntary the values of those parameters; the tax official can effect on those values by varying the parameter π – amount of costs, directed to control of taxpayer’s actions.

We assume that the values of those functions can have a significant impact on the behavior both of taxpayer and tax official. The answer on question about the interdependence between p и q is not obvious. In a first approximation we can assume that the increase of π leads to increase of p and to decrease of q.

Our research is based on the assumption that the whole set of interactions between taxpayers and tax officials is situated, generally, in one or another of three Nash equilibriums in pure strategies game (1-5): (p_0; a_0), (p_1; a_0), (p_1; a_1), because the equilibrium in mixed strategies is not stable and it is not achievable in practice and the equilibrium in pure strategies (p_0; a_1) is not possible.

The conditions of achievement of each of three Nash equilibriums are the following. $(pr_0;ag_0)$: when the taxpayer uses the strategy ag_0, for tax official the using of strategy pr_0 must be more profitable than pr_1; simultaneously, when the tax official uses the strategy pr_0, for taxpayer the using of strategy ag_0 must be more profitable than ag_1:

$$(pr_0;ag_0):\quad g_{00} < g_{10};\ h_{00} < h_{01} = p(\pi)\big(\tau R + \gamma(\tau R)\big) - \pi < 0; R > (1-\tau)R.$$

Similarly, for equilibriums $(pr_1;ag_0)$ and $(pr_1;ag_1)$ we have:

$$\begin{aligned}&(pr_1;ag_0):\quad g_{00} > g_{10};\ h_{10} > h_{11} = \\ &= p(\pi)\big(\tau R + \gamma(\tau R)\big) - \pi > 0; R - p(\pi)\big(\tau R + \gamma(\tau R)\big) > R - \Big(\tau R + q(\pi)\big(\tau R + \gamma(\tau R)\big)\Big)\end{aligned}.$$

$$\begin{aligned}&(pr_1;ag_1):\quad g_{01} < g_{11}; h_{10} < h_{11} = \\ &\quad = \tau R < \tau R + q(\pi)\big(\tau R + \gamma(\tau R)\big) - \pi > 0;\quad R - p(\pi)\big(\tau R + \gamma(\tau R)\big) > R - \Big(\tau R + q(\pi)\big(\tau R + \gamma(\tau R)\big)\Big)\end{aligned}.$$

After little transformations we obtain conditions for Nash equilibriums:

$$(pr_0;ag_0):\quad \tau R + \gamma(\tau R) < \frac{\pi}{p(\pi)}; \tag{6}$$

$$(pr_1;ag_0):\quad \tau R + \gamma(\tau R) > \frac{\pi}{p(\pi)} \quad \wedge \quad \left(\frac{\tau R}{\tau R + \gamma(\tau R)} > p(\pi) - q(\pi)\right); \tag{7}$$

$$(pr_1; ag_1):\quad \tau R + \gamma(\tau R) > \frac{\pi}{q(\pi)} \quad \wedge \quad \left(\frac{\tau R}{\tau R + \gamma(\tau R)} < p(\pi) - q(\pi) \right). \qquad (8)$$

The players' behavior, evidently depends on given values of parameters (pattern of functions) $\gamma(\pi R)$, $p(\pi)$ и $q(\pi)$.

Estimation of those parameters as well as empirical evaluation of given model call for further investigations.

Conclusion

Problem of identifying the unfairness of taxpayers' behavior is complex. As a result, there is a possibility of erroneously identified tax violation (in absence of tax evasion or bribes). Our models suggest that interaction between taxpayers and tax official can be described as one of three of Nash equilibriums.

In this spirit, we'll be able to estimate real tax revenue. If official data of tax revenue, obtained from credible sources, will differ from modeled results, one can assume the presence of large corrupt practices, notably by way of agreement between taxpayer and tax official.

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