



An Expository Analysis of Tax evasion and Policy Formulation using Game Theory

Dipak Kumar Satpathi, B.Jagadish Chandra and A Ramu
Department of Mathematics
BITS-Pilani, Hyderabad Campus,
Andhra Pradesh-500078
India

Abstract: In the standard models of tax compliance, it is assumed that the honest or cheating behaviour of the taxpayer is driven primarily by the payoffs he/she gets from their behaviour. In contrast to this view, there has been considerable empirical evidence which suggest that many taxpayers' decisions are affected by their principles and moral values while reporting their income to the tax authorities. In this paper, a game-theoretic model of tax compliance that includes a proportion of taxpayers who have 'tax morale' which influences their decision making is studied. This is modelled as a game between the governments which chooses whether or not to audit a taxpayer and the taxpayers who choose whether or not to be honest in paying their taxes. This is a game of imperfect information as the assumption that the government does not know the actual income of each of the taxpayer. It is shown that including this behaviour of taxpayers leads to significantly different empirical predictions and somewhat different policy implications.

Keywords: Audit, Evasion, Game, Policy, Taxpayer

I. Introduction

The conventional models of tax compliance assume that the taxpayer's behavior is driven by the incentives of the tax system. According to these models, the taxpayers choose either to be honest or evasive depending on the payoffs they obtain in each case. This view of taxpayer behavior was first presented in the context of a formal model by [1] and [2], and it has continued to occupy a central place in the work of [3], who presented a game-theoretic analysis that incorporates the strategic behavior of the tax agency into the formal analysis, providing link between tax agency audit policies and taxpayer reporting decisions for related models using a principal-agent framework). In all these models taxpayers show a similar willingness to cheat, differing in this regard only in their attitudes toward risk and their opportunities for evasion. Tax evasion was treated as a risky asset, which is usually determined by Tax Audit and penalty rate. The behavior of tax compliance has been popularly explained by the punishment oriented policies (as tax audit and penalty rate). Several other researchers have done significant work in this lines ([4]-[6]).

Recent decades have also seen number of attempts to provide empirical estimates of the size of the "hidden economy". The empirical work in this area was little. Empirical work and the policy discussions that followed from it gave inspiration to further theoretical work; theory also gave new directions for the empirical investigations. The survey of the literature through 1980's was done by [7]; other surveys include [8]-[11].

In the present paper, we have modeled the tax system as a game between the government and individual income tax payer, and tried to arrive at some conclusions regarding the tax compliance behavior and optimal policy formulation. The effect of "morale" among the taxpayers has been incorporated by adding a satisfaction payoff of "S" on being honest for those taxpayers who have morale. This satisfaction payoff plays a role in the taxpayer's decisions. The case of individual income tax has been considered. The behavior of both the government and tax payers with the changes in tax rate, penalty rate and cost of auditing are also analyzed. The effects when more number of people has the 'tax morale' and the satisfaction derived by being honest are also analyzed.

II. The Model

The model we have adopted is a modified form of Allingham and Sandmo (A-S) mode [1]. We present the model as a game between the government and the tax payers. The ingredients of the game are as follows:

The Players:

The players in this game theoretic model are the government and individual tax payers.

Strategies:

The tax payer has to choose between completely disclosing his income and not disclosing. This means that he has to choose between Honest (H) and Cheat (C). Also, we will assume that he can disclose his entire income correctly or not disclose any. This means that when he cheats and not audited by the government, he need not pay any tax. The government has to choose between auditing (A) and not auditing (NA) the taxpayer.

Payoffs:

It is assumed that the income of a particular tax payer to be 'X'. The government is not aware of the actual income of any particular taxpayer. It will be known only when he/she is audited. The tax charged is a proportional tax i.e. a proportion 't' of the income has to be paid as tax. We assume that the cost to the government for auditing any tax payer to be 'S'. Further, when a taxpayer Cheats and is audited, he will be found to be guilty and has to pay a penalty as a proportion 'T' ($>t$) of the income 'X'. The payoff for the taxpayer is taken as the income remaining after the taxation. The payoff for the government is the tax revenue obtained less the cost of auditing (in case if the government audits the tax payer). An assumption made in this model is that the taxpayers know how much it costs the government to audit a taxpayer i.e. 'S'. Thus the game in the Normal form is given below:

Government/ Tax payer	Honest (H)	Cheat (C)
Audit (A)	$tX - S, X - tX$	$TX - S, X - TX$
Not Audit (NA)	$tX, X - tX$	$0, X$

The solution to this game and hence the equilibrium actions of each of the players can be obtained by finding the Nash Equilibrium to the above game. The best responses for each of the player are as follows:

For Government: Best Response against Honest (H) is Not Audit (NA)

Best Response against Cheat (C) is Audit (A)

For Tax-payers: Best Response against Audit (A) is to be Honest (H)

Best Response against Not Audit (NA) is to Cheat (C)

Thus there is **NO Pure strategy Nash Equilibrium** (an assumption made here is that the cost of auditing (S) is not larger than the penalty received (TX). Otherwise for a sufficiently large 'S', a pure strategy equilibrium would be (NA, C) – Not Audit, Cheat).

So, we claim that the possible Nash Equilibrium existing in this model has to be a Mixed Strategy Nash Equilibrium. We assume that the government mixes A and NA with probabilities of 'p' and '(1-p)' respectively. The taxpayers mix H and C with probabilities 'q' and '(1-q)' respectively. The payoff table with this mix can be shown as:

Government/ Tax payer		Honest (H)	q	Cheat (C)	(1-q)
Audit (A)	p	tX - S, X- tX		TX – S, X – TX	
Not Audit (NA)	(1-p)	tX, X – tX		0, X	

The expected payoff of mixed strategy is the weighted average of the payoffs of each of the pure strategies in the mix. The mixed strategies shown above for each of the players should be best responses to the mix of each of the other players in the game so that the combination could be a Nash Equilibrium. An important property of mixed strategies is that "If a mixed strategy is a best response to a particular strategy, then each of the pure strategies in the mix must themselves be best responses to that particular strategy.

In this simultaneous setting where we have assumed that both government and taxpayers will be choosing their actions simultaneously, the equilibrium audit rate is found to be independent of the income of the individual taxpayer.

III. Adding Tax Moral to the Model

Now, we will consider an important modification to the model discussed so far. We will introduce the concept of "morale" in the taxpayers. We may define tax morale as the intrinsic motivation to pay taxes arising from the moral obligation to pay taxes or the satisfaction one receives by contributing to society by paying taxes honestly. This tax morale is introduced into the model using a satisfaction value 'M' to the taxpayers who pay taxes correctly i.e. who are Honest (H). We also assume that a proportion ' α ' of the taxpayers have this morale and the remaining (1- α) are neutral. The payoff table for the game between these taxpayers having morale and the government can be shown as given:

Government/ Tax payer		Honest (H)	q	Cheat (C)	(1-q)
Audit (A)	p	tX - S, X- tX + M		TX – C, X – TX	
Not Audit (NA)	(1-p)	tX, X –tX + M		0, X	

Note that the satisfaction from paying taxes correctly has been added to the payoff of the taxpayers when they are honest (H). We can still show that there is no pure strategy Nash equilibrium. Thus the table is shown along with the mixing of strategies. The same procedure as before can be used to solve for the equilibrium mix of government and tax payers.

Mix of government:

The expected payoff to the taxpayers against the government's mix (p, 1-p) from:

Honest (H): $p*(X-tX+M) + (1-p)*(X - tX + M)$ **Cheat (C):** $p*(X-TX) + (1-p)*X$

The both payoffs should be equal. Equating both, we get the mix of government as:

$$p = \frac{tX - M}{TX} \quad \text{and} \quad 1 - p = \frac{TX - tX + M}{TX}$$

Mix of Taxpayers:

The expected payoff to the government against the taxpayer's mix (q, 1-q) from:

Audit (A): $q*(tX-S) + (1-q)*(TX-S)$ **Not Audit (NA):** $q*(tX) + (1-q)*(0)$

Both the payoffs should be equal and equating we get the mix of taxpayers as:

$$q = \frac{TX - S}{TX} \quad \text{and} \quad 1 - q = \frac{S}{TX}$$

This compliance rate for taxpayers with morale is also same as that of [12]. The reason for this result (no difference in compliance rate between taxpayers with and without morale) can be explained as follows. Because of their morale, the taxpayers tend to be more compliant. This existence of morale among the taxpayers causes the government to reduce their audit rate (can be seen from the mix of the government obtained above). This reduction in audit rate leads some more taxpayers to evade tax and thus causes the compliance rate to decrease. Overall, there is no change in the compliance rate.

Thus, we have obtained the mixed strategy Nash Equilibrium as:

$$\left(\left(\frac{tX-M}{TX}, \frac{TX-tX+M}{TX} \right), \left(\frac{TX-S}{TX}, \frac{S}{TX} \right) \right)$$

The results for the neutral taxpayers in the case of no moral will be obtained by putting $M=0$. The mixed strategy equilibrium for the whole population can be obtained as the weighted average of the mixes of both types of taxpayers.

Tax morale case:

$$\left(\left(\frac{tX-M}{TX}, \frac{TX-tX+M}{TX} \right), \left(\frac{TX-S}{TX}, \frac{S}{TX} \right) \right) \text{ which is '}\alpha\text{' of total population.}$$

Tax neutral case:

$$\left(\left(\frac{t}{T}, \frac{T-t}{T} \right), \left(\frac{TX-S}{TX}, \frac{S}{TX} \right) \right) \text{ which is (1-}\alpha\text{) of total population.}$$

The Nash Equilibrium mix of the whole population consisting of both tax morale and tax neutral taxpayers is:

$$\alpha * \left(\left(\frac{tX-M}{TX}, \frac{TX-tX+M}{TX} \right), \left(\frac{TX-S}{TX}, \frac{S}{TX} \right) \right) + (1-\alpha) * \left(\left(\frac{t}{T}, \frac{T-t}{T} \right), \left(\frac{TX-S}{TX}, \frac{S}{TX} \right) \right)$$

The above mix turns out to be:

$$\left(\left(\frac{tX-\alpha M}{TX}, \frac{TX-tX+\alpha M}{TX} \right), \left(\frac{TX-S}{TX}, \frac{S}{TX} \right) \right)$$

In the case of no moral we have to put $M=0$ and the expression is same as [12].

IV. Discussion

With the introduction of tax morale in the taxpayers, there is no change in the effective compliance rate. But the government is benefitted by having to audit less number of taxpayers and thus reduce its costs.

' α ' (the proportion of the taxpayers have the moral) can be seen as the probability that a randomly chosen taxpayer will have a tax morale of value 'M'. When the tax to be paid by a particular group of taxpayers equals the expected value of tax morale they have ($tx = \alpha M$ for some x), the government need not audit those. But, this cannot be implemented by the government as they do not have complete idea about the actual income of the taxpayer.

As the proportion of people with tax morale increases i.e. as ' α ' increases, the audit rate can be decreased. As the value of morale to the taxpayers, i.e. M increases, the audit rate can be decreased thus improving the welfare of the society as a whole. This model is also consistent with the all the results discussed in [12].

The tax compliance can be improved either by increasing the penalties (T) or by decreasing the cost of audit (S) which can be done by formulating efficient audit methods. We also see that with the increase in the income of the people, the tax compliance rate increases and also the audit rate. This implies that when a taxpayer has a high value of 'X' (more money has to be paid as tax, implying more money is at stake) i.e. when he/she is rich, this does not mean that the particular taxpayer is going to cheat more. This just means that he/she will be getting audited more.

It is very important for any economy to raise the revenue through taxation to cater the needs of development of the economy. Tax Compliance has become an important issue in the tax system. This paper

models the tax-paying system as a game between the government and taxpayers and tries to address the issue of tax compliance. The results of this model suggest that the tax compliance can be increased by increasing the penalties of tax evasion or by creating an efficient audit system so that the costs of auditing are minimized. When the cost to the government of auditing a taxpayer is made very low or nearly '0', then this model suggests that compliance rate up to 100% can be achieved. When the government sets a high tax rate, it has to audit more number of taxpayers at the equilibrium. The number of taxpayers to be audited will decrease with the increase in the penalty rate.

When the taxpayers have a sense of moral obligation or "tax morale", then the equilibrium audit rate of the government is found to decrease with increase in the value of satisfaction to the taxpayers by correctly paying taxes. Audit rate is also found to decrease with the increase in the proportion of the people having this tax morale. So, government can try to educate the people about the need for taxpayers to pay taxes honestly and how they contribute to economic development through this. These programs increase both 'M' and ' α ' (value of satisfaction and proportion of taxpayers having tax morale) discussed in the model.

References

- [1] M. G. Allingham, and A. Sandmo, "Income tax evasion: A theoretical analysis," *Journal of Public Economics*, 1972, 323-338.
- [2] T. N. Srinivasan, "Tax evasion: A model," *Journal of public economics*, 2, 1973, 339-346.
- [3] J. F. Reinganum, and L. L. Wilde, "Income tax compliance in a principal agent frame work," *Journal of public economics*, 26, 1985, 1-18.
- [4] Slemrod, Joel, and Shlomo Yitzhaki. "Tax Avoidance, Evasion, and Administration." In *Handbook of Public Economics*, edited by Alan J. Auerbach and Martin Feldstein (1423-70). Amsterdam, The Netherlands: Elsevier Science Publishers B.V., 2002.
- [5] Hyun, J., "Tax Compliances in Korea and Japan: Why are they different?" Discussion paper at seminar held by Policy Research Institute, Ministry of Finance, Japan, 2005.
- [6] J. Alm, B. Roy and Murray, "Audit selection and income tax underreporting in the tax compliance game," *Journal of Development Economics*, Vol 42(1), 1993, 1-33.
- [7] F. Cowell, Frank A. *Cheating the Government: The Economics of Tax Evasion*. Cambridge, MA: MIT Press, 1990.
- [8] James Andreoni; Brian Erard, "Tax Compliance," Jonathan Feinstein," *Journal of Economic Literature*, Vol. 36(2), 1998, 818-860.
- [9] J. Alm, G. McClelland and W. Schulze, "Why do people pay taxes?" *Journal of Public Economics*, 48, 1992, 21-38.
- [10] C. Fischer, M. Wartick and M. Mark, "Detection probability and taxpayer compliance: A literature review," *Journal of Accounting Literature*, Vol. 11(1), 1992, 1-46.
- [11] J F. A. Cowell, unpublished paper, London School of Economics, 2002.
- [12] D. K. Satpathi and B. J. Chandra, "The theory of tax evasion and policy formulation: A game theoretic approach," *International Journal of Engineering, Business and Enterprise Applications*, Vol 4(1), 2013, 31-34