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The design and revenue impact of a tax receipts lottery: A lab experiment in Tanzania

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The Design and Revenue Impact of a Tax Receipts Lottery: A Lab Experiment in Tanzania

by

Cyril Chimilila, Remidius Ruhinduka and Vincent Leyaro

Abstract

Most sub-Saharan African countries are characterized by low tax compliance and low tax productivity. This study tests the effects of a tax lottery under alternative reward designs on compliance as an alternative policy option for addressing the problem of low tax receipts in Tanzania. The lab experiment involved the purchase of goods with a sample of 313 undergraduate students recruited from courses with and without tax specialization. The experiment participants were randomly assigned in control and treatment groups and thereafter assigned random endowment incomes. In the treatment groups two treatments were administered: a lottery of high probability and low rewards, and a lottery of low probability and high rewards, where eligibility for the lottery was restricted to those who paid VAT on the purchase (which would be cheaper otherwise). The results of the experiment show that a lottery of high reward has a higher impact on compliance and revenue. Our estimates show that the net revenue effects of these lotteries differ by 27 percent. Hence, the design of a tax lottery is important. Further, tax lotteries have the potential to improve taxpayer compliance and increasing revenue collection.

JEL Classification: H20, H26, H30

Keywords: VAT compliance, tax lottery experiment, rewards design, Tanzania



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1. Introduction

The need to raise more taxes to finance government expenditure is of increasing priority in developing countries given the general decline in aid flows and high risk associated with debt. In sub-Saharan Africa (SSA) the level of tax compliance and tax effort (in terms of revenue as a share of GDP) remains low. The UNU-WIDER Government Revenue Dataset (GRD) shows that tax-to-GDP for Tanzania stands at an average of 11.7 per cent, lower than the SSA average of 18 per cent and even lower than neighbouring countries with similar economic structures (GRD, 2021).

Efforts to enhance tax compliance and increase tax revenue collection included several tax policy reform measures, implemented in waves of reforms over a long period of time. The inherited colonial system was massively reformed in the late 1980s and early 1990s with the abolition of a number of perceived to be nuisance taxes and those which were uncertain and administratively costly. Another wave of reforms in the mid to late 1990s included the establishment of an autonomous tax administration body – the Tanzania Revenue Authority (TRA) in 1996. This was followed by reforms including introduction of the Value Added Tax (VAT) in 1998 that replaced the sales tax. In early 2000s there was yet another wave of reforms with the introduction of Income Tax Act 2004 repealing the Income Tax Act 1993, a reduction in the VAT rate from 20 per cent to 18 per cent and the changes in VAT Act in 2014 addressing the issue of tax incentives such as tax exemptions (Osoro, 1993; Fjeldstad, 1995; Commission on Tax Reforms, 1992; URT, 2014).¹

In addition to these reforms, various measures were taken to improve and modernize the tax administration. Amongst these reforms were the introduction of VAT in order to enhance revenue collection and increased use of information and communication technology (ICT). The enhanced use of ICT aims to simplify the tax collection system, reduce compliance costs, enhance taxpayer convenience, improve tax administration and hence increase tax revenue collection (IMF, 2015; Kim and Kim, 2018). Specifically, for VAT, electronic fiscal devices (EFDs) were introduced to aid issuance of receipts, record keeping and provide information to the tax administration; this was ought to enhance tax compliance. However, ever since the introduction of EFD its use has been very limited and compliance remained very low. Consequently, the tax administration introduced high penalty for not using EFD,

¹ The changes in tax rates are reflected in various Finance Acts.

but compliance generally remains low. Also, these physical enforcements of visiting business premises to investigate the use of receipts and impose penalties is very costly and inconvenient. As the compliance of issuing and demanding receipts for VAT is substantially low in Tanzania, this study sets out to assess for the case of VAT, that significantly depends on sales and purchase receipts, alternative approaches that can enhance compliance of EFD receipts to enhance VAT compliance. In particular, the study attempts to examine whether tax lottery and rewards can act as incentives for people to demand the receipts as a way of increasing compliance and by extension increase net tax revenue collection.

A common method used to measure and compare VAT collection performance is the VAT collection efficiency (C-efficiency) framework considering all parameters that affect revenue collection, including structural characteristics of VAT, various economic and social factors, and tax policy issues such as prevalence of exemptions, exclusions, and zero rates (Ueda, 2017; Cnossen, 2019). Cnossen (2019) presents the performance of VAT collection across selected African countries and the results show that Tanzania is underperforming with a VAT C-efficiency at just 0.2, far less than a unit (high performance) and below the African average of 0.37. The benchmark of performance is often a cut-off point of 0.5, below which a country is considered to have a low performance. Factors which undermine the VAT performance include tax administration capacity, tax policy (exemptions, reduced rates and thresholds) and economic – dominance of a subsistence agriculture and informal sectors, and shorter supply chains with little value-additions.

More importantly, the observed low VAT performance is largely a result of noncompliance behaviour of the taxpayers. Compliance can be shaped through norms, rewards and threats (Brockman *et al.*, 2016). With regard to norms, citizens' perception of fairness of taxes, treatment by the tax authority, perceived good use of tax money by the government is likely to reciprocate in terms of compliance in paying taxes (Torgler 2002; Ali *et al.*, 2014). Threats involve the perception of detection and punishment by the tax administration. The degree of detection depends on audits and physical enforcements. However, physical enforcement, such as taking a policeman-like approach, is limited by resources constraints and achieving higher compliance levels may demand alternative innovative approaches, which are more efficiency and cost-effective. Tax lotteries and rewards are among the novel ideas which can achieve compliance improvements without significant additional costs to the government (Fabbri and Hemels, 2013; Naritomi, 2019).

Empirical evidence shows that tax lotteries improve tax compliance (Alm *et al.*, 1992; Naritomi, 2019; Slemrod *et al.*, 2019). Despite their increasing use across tax jurisdictions, tax lotteries have not gained prominence. While lotteries appear to offer potential in tax compliance and revenue collection, there is a need to test this new policy option in country specific environment as drivers of effectiveness of this intervention may differ from country to country. On one hand, this study is designed to contribute on that strand of the literature. On the other hand, unlike experiments conducted to evaluate the impact of lotteries alone, this study experimentally estimates the potential impact of not only the lottery but also whether it matters on how its rewards are designed as a strategy for enhancing VAT compliance. We proceed by estimating the demand for tax lottery, then examine the treatment effects of lottery designs and lastly estimate the net revenue effect of the lottery.

We use laboratory experiment approach adopting a similar design as that adopted in common tax compliance experiments. These designs were implemented in the Allingham-Sandmo framework and the treatments involved include the probability of audit, detection and punishments for noncompliance. Modifications of this framework included the use of rewards (both pecuniary and non-pecuniary) instead of punishment. This study follows the strand of studies (see Alm *et al.*, 1992), which involves tax lottery as a mechanism of inducing compliance and increasing net revenue collection. Our study provides three contributions. One, this is the first study in Tanzania (to the best of our knowledge) to experimentally test the role of lotteries to foster tax compliance. Two, we explore different treatments to capture the role of reward design on compliance. Three, we explore the importance of taxpayer awareness on compliance.

The rest of the paper is organized as follows. Section two presents a review of literature. Section three presents the methodology. Section four discuss the findings and Section five summarizes and provide implications of the study.

2. Review of Literature

2.1 Tanzania Context: VAT Administration and Compliance

The Value Added Tax (VAT) was introduced in Tanzania in 1998 to replace sales tax following a wave of preceding decades of VAT adoption in most other developing countries across the world. The factors which drove adoption of VAT include its neutrality with respect to international trade and absence of distortion in domestic production and

distribution (Fjeldstad, 1995). In addition, VAT has stable revenue because it is based on consumption which tends to fluctuate very little; and is collected at different stages along the value chain and hence tends to have a broader tax base and more revenue as compared to sales tax.

Of the three types of VAT – consumption VAT, income VAT and gross product VAT, Tanzania adopted consumption VAT with a credit-invoice method of computation. The consumption VAT (C-VAT) is the most common type. The tax is levied on the total value of sales at each stage of production and allows a credit for any VAT paid on inputs in production (Fjeldstad 1995, Mrema, 2012). Using a credit method, VAT payable by the trade is the difference between the tax collected on its sales (output tax) and the tax it paid on its purchases (input tax), and in this way it is the consumer who bears the ultimate burden of the VAT while the merchant acts just as a tax collection agent.

The invoice-credit VAT system is advantageous in a tax jurisdiction with many traders who have poor capability of record keeping. Even though, this system has challenges given its administrative complexity and costs due to high requirement of audit trail. Furthermore, the compliance strategy used in Tanzania is self-assessment where a VAT registered trader declares the output tax, input tax and tax payable. There is compliance risk on over declaration of input tax or under declaration of output tax. Under high informality and low usage of tax invoices and receipts, the risk becomes very high and VAT collection is undermined (Sokolovska and Sokolovskyi, 2015). VAT non-compliance is chiefly manifested in these practices: traders over claiming on input tax, non-issuance of receipts, deliberate falsification of invoices and receipt, and collusion between traders and buyers (Fjeldstad *et al*, 2008; Wilks *et al*, 2019). In high noncompliance and weak tax administration capacity, a sizable number of eligible taxpayers may not be registered and even if they are registered, they may not file returns and pay taxes. Enforcing VAT compliance in part relies on sophisticated cross-checking and computerization (Fjeldstad, 1995). As such, several ICT systems are in use including the ITAX System, electronic filling of VAT returns and Electronic Fiscal Devices (EFD) in Tanzania.

VAT relies on receipts on purchases and in Tanzania EFD are used for this purpose. The main challenge with EFD has been a low compliance among citizens. In Tanzania, the government has put special emphasis on the development of norms and the use of deterrence mechanisms including high level campaigns insisting citizens to demand receipts for enabling the government to collect taxes for national development and penalties for non-

issuance of receipts. It is important to note that rewards for issuance or demand of receipt have not yet been introduced in Tanzania. It is interesting that despite the campaigns and stringent sanctions for not taking or issuing EFD receipts, many traders do not issue receipts and customers do not comply by asking for receipts. In some cases, customers collude with traders to understate the value of goods for sharing the evaded VAT. It is very common in Tanzania for customers to negotiate price decrease by a large amount even in formal outlets, which tempts negotiations between a trader and a customer about whether to issue receipt or not or to understate the value on the receipt to be issued. In a study by Fjeldstad *et al.*, (2018), it was found that 40 percent of traders do not issue receipts and that EFD compliance is strongly associated with the customer's perception of detection and penalty risks. Given the operating environment where most businesses are very small, monitoring is complicated and as a result customers perceive a low chance of detection and punishment. Increasing enforcement is however challenged by resources, cost and in some cases integrity of those who are to do enforcement. An alternative to direct enforcement can be rewarding taxpayers to comply. The use of incentives for inducing tax compliance have been tried elsewhere and yielded impressive results (Marchese, 2009; Fabbri and Hemels, 2013; Naritomi, 2019).

2.2 VAT Compliance

The Value Added Tax (VAT) is collected from consumptions. Therefore, the performance in VAT collection is largely dependent on the compliance in reporting of these consumption transactions (see De Mooij and Keen, 2015). A standard economic model (Allingham and Sandmo, 1972) predicts that taxpayers engage in tax evasion for the motive of maximizing expected utility from after tax income given the chances of detection and the penalties, such that when chances of detection is high and penalties are high, they comply. This model predicts a direct deterrence mechanism. Compliance can be influenced also by development of compliance norms in a society and economic conditions. A large informal sector, for example poses a huge challenge for enforcing compliance in most parts of sub-Saharan Africa.

For the large part of sub-Saharan Africa, VAT was introduced in 1990s to boost revenue performance. VAT has a broad tax base as it is collected at different stages of a value chain. The compliance and revenue collection performance of VAT is to a large extent depends on correct reporting of sales and purchases. In Tanzania, in order to improve the record keeping and reporting of transactions for VAT purposes, electronic fiscal devices were introduced.

Despite this initiative, compliance remained low as most traders do not issue receipts and buyers do not demand receipts. Evasion is in the form of not issuing receipts, under reporting of sales, over claiming input taxes, or deliberate bargaining between traders and buyers to undermine tax payment. Due to low VAT receipts compliance, the authorities had to introduce stringent penalties for not compliance with EFD receipts, but still the situation is not impressive. However, monitoring of these transactions is difficult and costly in the absence of technologies and risk-based strategies.

A recent innovation in this area is the use of tax lotteries. Tax lotteries are considered to be alternative mechanisms for inducing taxpayers reporting (Wan, 2006; Naritomi, 2018). As such, tax lotteries have been used in various countries and have shown effectiveness in improving reporting of sales and reducing VAT noncompliance (see Dragoş *et al.*, 2015). However, lotteries are effective only when the level of compliance after lottery is higher than without lottery. This requires a good design of the rewards that can stimulate and incentivize taxpayers to comply (Perez and Humphreys, 2013; Brockman *et al.*, 2016).

2.3 Tax lottery as a compliance incentive

Tax lotteries and rewards have emerged to be an alternative option for curbing tax evasion by incentivizing taxpayer compliance and provide additional information to the tax administration for enforcing compliance of traders. Several studies reported the use of this strategy across the world, for example China (Wan, 2006), Romania (Ungureanu and Dascălu, 2015), Italy (Bernasconi and Bernhofer, 2017), Portugal (Wilks *et al.*, 2018) and Brazil (Naritomi, 2019), to mention a few. These studies concluded that tax lotteries have potential for improving revenue mobilization, especially for GST and VAT. This is because lotteries incentivize taxpayers to comply by demanding receipts and therefore introduce risks of detection to the traders.

Rewards used for tax lotteries range from direct monetary incentives such as tax credits and prizes, to non-monetary incentives, such as recognition and honour (see, for example, Slemrod *et al.*, 2019). It is however possible to monetize these pecuniary incentives (see Akerlof and Kranton, 2000). The compliance effect of rewards from tax lottery can last for a long period (Fabbri and Hemels, 2013). According to Fabbri and Hemels (2013) in a society where tax evasion is widespread, in the form of traders do not issue invoices (or receipts) and the behaviour is socially accepted or tolerated (buyers do not ask for receipts),

lottery offer a positive private incentive for consumers to start reacting by asking invoices even from traders who used to systematically evade taxes by not issuing invoices. However, for lottery to be effective the size of rewards must be incentive compatible, otherwise taxpayers can outweigh the incentive and accept evasion (Fuster and Meier, 2010; Fabbri and Hemels, 2013).

Studies have shown that the tax lotteries can have long-run positive externalities. A lottery introduces an external shock that could lead to more consumers adopting more socially efficient behaviour (for asking for invoices) and this initiates a process of social norm creation (Fabbri and Hemels, 2013). These positive externalities may continue to flow even if the initial investment and incentives mechanism lasts for a limited period of time, thus making lottery one of cost-effective mechanism of enforcing compliance.

However, depending on the nature of reward, persistence in compliance may differ. Carrillo *et al.* (2017) examined the impact on persistence of compliance of alternative rewards by comparing the effects of recognition and construction of sidewalks for compliance in property taxes. They found that the provision of durable and visible goods, construction of sidewalks for compliant taxpayers has a positive and persistent effects on future compliance as well as positive spill over to neighbours. Similarly, Koessler *et al.*, (2018) found that non-financial rewards are more effective in inducing compliance as compared to financial rewards. Therefore, there is no one-size-fits-all when it comes to approach to boost tax compliance. The issue of proper designing of rewards is paramount if lotteries are to achieve positive impact across a broad spectrum of taxpayers. This should be more of an issue in low-income countries like Tanzania where financial resources to the tax administration may be limited for lotteries and incentives.

A tax lottery introduces rewards to incentivize taxpayers (consumers) to comply by demanding receipts for their transactions (Naritomi, 2018). This way lottery may also save as an additional mechanism to ensure compliance of the traders. The design of tax lottery and rewards have used both pecuniary and non-pecuniary rewards (Slemrod *et al.*, 2019). The evidence on the reward design based on the probability are limited if no at all. Therefore, this study is among those trying to establish whether the design of rewards based on probability matters for incentivizing taxpayer compliance. Since various reward designs have different effects in terms of compliance levels and the cost of administering a lottery which in turn affect the net revenue effect, information about reward designs is crucial to the tax administration and for informed policy making.

2.4 A review of tax compliance experiments

Traditionally, studies that seek to elicit compliance behaviour have used econometric analyses of existing data. The difficulty in observing behaviour responses in econometric analyses led to a shift of emphasis to surveys analysis. Surveys enables to uncover the levels of evasion behaviour through self-reports and explore beliefs and attitudes towards the subject, such as perceived probability of detection, acceptability of evasion, and views about the prevalence of non-compliance (Hallsworth, 2014). However, the major limitation of surveys is the possibility of concealing non-compliance behaviour by the respondents. As such, the experimentation method of research found its way from natural sciences into social studies examining behavioural responses.

The successes in early lab experiments in proving economic theories in 1960s (see for example Smith, 1962) and subsequent successes in explaining economic theories and evaluation of economic policies made experimental economics a large and productive sub-discipline whose reach is still expanding. More and more usage of the experiment method is being reported. Despite the much successes and usefulness of experiments on explaining the determinants of tax compliance behaviour and testing alternative approaches for improving tax compliance, their use in sub-Saharan Africa has been very limited, with just a handful of them (see Mascagni *et al.*, 2016).

One area that has gained prominence in behavioural studies is tax compliance. Tax experiments can be performed in the field, lab or use administrative data and information trails reported by firms to the tax administration. In taxation, experiments have been widely used to study determinants of taxpayer compliance (see for example Alm *et al.*, 1992; Blumenthal *et al.*, 1998; Torgler, 2003; Castro and Scartascini, 2013; Choo *et al.*, 2013; Hallsworth *et al.*, 2014; Almunia and Lopez-Rodriguez, 2015; Brockmann *et al.*, 2016; Mascagni *et al.*, 2016). The use of actual incomes, incentives and rewards in experiments is incentive-compatible in revelation of actual taxpayer behaviour.

3. Empirical Strategy and Methodology

4.1 Experiment design and procedure

We implement a laboratory experiment with 313 undergraduate university students. To ensure that we test and control for the effect of tax awareness, we conducted the experiments at the tax specialized and non-tax-specialized universities. For tax-specialized, we conducted

the experiment for Bachelor in Tax Management students at the Institute of Tax Administration (ITA)) and for non-tax specialized we conducted the experiment at Moshi Cooperative University (MoCU). These universities are located in separate geographical regions in Dar es Salaam and Kilimanjaro, respectively. Participation to the experiment was voluntary, only students that positively responded to our recruitment call took part in the experiment.

Our experiment was designed to test both the role of lotteries, and whether it also matters on how rewards are designed to foster compliance. To allow this, recruited subjects were randomly distributed to five groups: two control and three treatment groups. The participants were randomly separated into control and treatment groups through random picking of puckered pieces of paper in the ballot box printed with venue names assigned to control and treatment. At the ITA three experiment rooms were designated (two treatments and one control) and at the MoCU two rooms (one control and one treatment). The experiment rooms were well separated and each room was labelled at the door so that students enter the right rooms they have picked. Experiment rooms were wide enough to allow arranging students at reasonable distance from one another to avoid deliberate discussion and sharing of information, which could lead to bias or invalidate the experiment. In order to ensure anonymous decision, in all experiments the participants used Alphanumeric codes printed on pieces of papers instead of their real names. So, if a participant picks randomly A_1 or B_2 or C_9 then the first letter A or B or C is the name of the experiment. These numbers were unique for each participant, that is $A_1, A_2, A_3, \dots, A_n$; $B_1, B_2, B_3, \dots, B_n$; and $C_1, C_2, C_3, \dots, C_n$.

The assignment of treatment was on groups. In the control group, participants were informed to choose to comply voluntarily. In the treatment groups, participants were informed about a tax lottery. Entry to the lottery depends on tax compliance such that those who decide to pay taxes automatically enter a lottery. More specific details are as provided in Annex 2.

In both control and treatment groups participants were assigned endowment incomes ranging between Tanzania shillings 5,000 and 10,000 to do some spending. The assignment of endowment incomes was random such that participants pick random puckered pieces of paper printed with income amounts. The proportion of assigned endowments were maintained in both control and treatments groups (60 percent received coupons of Shillings 5,000; 20 percent received coupons of Shillings 7,000; and 20 percent received coupons of

Shillings 10,000) so as to make the initial conditions of the groups similar in terms of incomes endowment (see Annex 2).

Because the experiment involves real purchase of goods, to make a real purchasing experience participants were not given cash but coupon of endowment incomes to spend at the cafeteria. Participants were informed that food is sold at a price of Shillings 5,000 (including VAT) or 4,000 excluding VAT. Furthermore, in the treatment groups participants were informed that if one chooses to pay VAT, he/she enters a lottery. The lottery involved two reward designs each administered in a separate experiment room. The first design involved a low probability and a high winning where one participant is chosen randomly to win Shillings 20,000. The second design involved a high probability and low winning where five participants are chosen randomly each to win Shillings 4,000 each. These instructions were printed in papers and each participant was given the papers with specific details of instructions as shown in Annex 2. Participants were instructed to fill in and retain them together with the pieces of papers that show their endowments.

After purchase and tax payment decisions were completed, specifically designed forms to serve as tax returns were distributed to each participant, where each participant is supposed to fill in their unique assigned number: endowment income, show up fee, price of food purchased and net income that they are supposed to be paid after deducting the cost of food. The tax declaration forms were verified and those participants who received treatment and declared tax returns were isolated and picked at random cards printed with rewards. A winner(s) reads out loud the prize. Then tax declaration forms were pinned together with endowment cards, prize cards, and experiment instruction sheets. Then, these packs of sheets were collected, verified and disbursements of net incomes were done. For each participant, net income is determined as show-up fee add endowment income and winning minus tax and food coupon. More details of experiment instructions are as provided in the Annex 2.

Lastly, a questionnaire was administered in order to elicit additional information including demographic and behavioural attributes of the subjects. Additionally, participants were given coupons of foods based on the price they have chosen (Shillings 5,000 for those who did not declare taxes and Shillings 4,000 for those who declare tax of Shillings 1,000). A list showing names of participants and value of food coupons were submitted to the University cafeteria, payments were made by the experimenter and participants were instructed to take food at their convenience. In the end we thanked the participants and announce the end of the experiment.

4.2 Analytical framework

Our analytical framework involves three stages. The first stage involves determination of the compliance level across groups of taxpayers, in the second stage we estimate the effect of the treatments (lottery designs) on compliance. The third stage involves estimation of net revenue effect. These stages are expounded as follows.

The impact of tax lottery on taxpayer compliance

The impact of tax lottery on taxpayer compliance was estimated using a binary logistic and linear probability models as presented in equation (1).

$$Y_i = \alpha + \beta X_i + \gamma T_i + \varepsilon_i \quad (1)$$

where T is a dummy equal to 1 for those who received a treatment and 0 for those who did not receive treatment. In this study there were two treatments, one treatment is a lottery of low probability and high rewards, and another treatment is a lottery of high probability and low rewards. X is set of other observed characteristics of the individual that affect taxpayer compliance. ε is an error term reflecting unobserved characteristics that also affect Y .

Determination of Net revenue of a tax lottery

Now that the conditions and the possibilities under which lottery improves compliance are known, the question at hand is “how can a tax lottery increase the net revenue of the government?”. A lottery is beneficial if it has a positive inducement to taxpayer compliance. A lottery increases revenue to the government if the incremental tax revenue is higher than the cost of administering it. Suppose that, due to evasion only a fraction of the potential taxes is collected (R_1) from expenditure (E) when a standard tax rate (τ) is imposed and the compliance level is (ϕ). Suppose also that, the government issues rewards (C) as a proportion (δ) of taxes collected. It follows that in the period after lottery the compliance and revenue increases, such that;

$$R_1 = \phi_1 E \tau \quad (2)$$

$$C = \delta R_1 \quad (3)$$

$$R_2 = \phi_2 E \tau \quad (4)$$

where R_2 and ϕ_2 are revenue and compliance level with a reward (C)

The net revenue effect (NR) of lottery is expressed as;

$$NR = R_2 - R_1 - C \quad (5)$$

$$NR = \phi_2 E\tau - \phi_1 E\tau - \delta \phi_1 E\tau \quad (6)$$

$$NR = Y\tau(\phi_2 - (1 + \delta)\phi_1) \quad (7)$$

Lottery increases net revenue *iff* $NR > 0$. Therefore, it follows that;

$$\phi_2 > (1 + \delta)\phi_1 \quad (8)$$

$$\delta < \frac{\phi_2}{\phi_1} - 1 \quad (9)$$

The intuition from equation (9) is that, unless the cost of administering a lottery is less than increased tax revenue due to implementation of a tax lottery program, a tax lottery has a positive net revenue effect. Achieving this is largely an issue of design.

4.3 Data and descriptive statistics

Data for this study were collected through both an experiments and a survey. A total of 313 undergraduate students from the Institute of Tax Administration (213 participants) and the Moshi University of Cooperative (100 participants) were the participants involved in the experiment. The distribution of participants according to gender is 143 (46 percent) were female and 170 (54 percent) males. In terms of distribution by age, majority, 83 percent were of the age between 20 and 24 years, 15 percent between 25 and 29 and only 2 percent were above 30 years. The average endowment income is Shillings 6,329; this is a significant level to be incentive compatible considering the average stipend which most students get (of about Tanzania 5,000 per day (approximately USD 2 per day)), and impliedly this amount is higher than the average food budget of students per day. In terms of risk, a score of 2.6 in a range of 1 to 5 may imply that the participants were average risk averse. The key variables with their definition and descriptive statistics are provided in Table 1.

Table 1: Descriptive Statistics

Variable	Definition	Obs.	Mean	Std. Dev.	Min	Max
comply	Comply with paying taxes, 1 if comply and 0 otherwise	313	0.783	0.413	0	1
gender	Gender of the participant, male = 1, female = 0	313	0.543	0.499	0	1
age	Age of participant	313	23.319	2.259	20	40
endowment income	endowment income provided for food purchase	313	6329.1	1944.0	5,000	10,000
tax major	Is the participant's discipline major, 1 if tax, 0 if other disciplines	313	0.681	0.467	0	1
treatment 1	A lottery of high probability and low winning, 1 if the subject receive a treatment, 0 if otherwise	313	0.23	0.422	0	1
treatment 2	A lottery of low probability and high winning, 1 if the subject receive a treatment, 0 if otherwise	313	0.367	0.483	0	1
risk attitude	Risk preference in engaging in a high risk bet of very low probability and a high cost, in a five-point scale, strongly do not prefer = 1 and strongly prefer = 5	312	2.696	1.461	1	5

Source: Authors own compilation

4. Empirical results and discussion

5.1 Results of compliance levels

The results on compliance levels are as depicted in Table 2. As it can be seen, treatment 1 was applied to tax specialized students only, while treatment 2 was applied to both tax specialized and non-tax specialized students. The overall compliance in both the control and treatments is 78.3 percent, however the overall compliance is higher among tax specialized students, about 81 percent than non-tax students, about 19 percent (of participants complied with paying tax). Compliance is high in the treatment groups than in the control group for

both tax specialized and non-tax specialized students. The compliance levels in the treatment groups among the tax specialized students and non-tax specialized students is about 72 percent. However, it is interesting that in the control groups, compliance is lower among the non-tax students, at about 60 percent, as compared to tax specialized students at about 76 percent. When the results are disaggregated for each treatment, as shown in Table 2, results show that the compliance for treatment 1 is 82 percent and for treatment 2 is 85 percent. The high compliance in treatment groups than in control groups imply that these treatments have positive effects on compliance. Furthermore, the results that compliance is higher among the tax specialized than non-tax specialized students may be explained by awareness on the tax matters among the tax specialized students, emphasizing the role of taxpayer awareness campaign or education to enhance tax compliance.

Table 2: Compliance levels by study major

Specialization/ Major	Control group		Overall	
	Comply	Not comply	Comply	Not comply
Tax	58 (76.32)*	18 (23.68)	173 (81.22)	40 (18.78)
Non-tax	30 (60.00)	20 (40.00)	72 (72.00)	28 (38.00)
Total	88 (69.84)	38 (30.16)	245 (78.27)	68 (21.73)

Specialization/ Major	Treatment 1		Treatment 2	
	Comply	Not comply	Comply	Not comply
Tax	59 (81.94)	13 (18.06)	56 (86.15)	9 (13.85)
Non-tax			42 (84.00)	8 (16.00)
Total	59 (81.94)	13 (18.06)	98 (85.22)	17 (14.78)

Source: Authors own compilation

Note: * Percentages in parentheses

5.2 The impact of tax lottery on compliance

The findings in Table 2 which indicate that compliance is higher in treatment groups suggests that tax lottery influence taxpayer compliance. This is further empirically investigated using regression analysis as presented in Table 3. The compliance was treated as a binary choice of paying taxes (comply) or not paying (not complying). As is shown in Table 3, the results of a linear model (OLS) and logistic model (marginal effects) are almost similar in terms of

parameter estimates and significance levels. Furthermore, both treatments have positive and statistically significant impact on compliance. The impacts of the treatments remained statistically significant even after controlling for risk attitude, age, gender and tax specialization.

Table 3: Impact of tax lottery on tax compliance

Variables	OLS		Logistic	
	(1)	(2)	(3)	(4)
Treatment_1	0.830*** (0.0452)	0.832*** (0.0475)	0.908*** (0.052)	0.9104*** (0.0508)
Treatment_2	0.851*** (0.0336)	0.850*** (0.0338)	0.935*** (0.033)	0.936*** (0.033)
Risk attitude	0.0224** (0.0107)	0.0227** (0.0109)	0.0596* (0.0315)	0.061* (0.0313)
Age		0.00555 (0.00428)		0.0187 (0.0166)
Gender		-0.00157 (0.0337)		-0.0032 (0.0823)
Tax major		0.000444 (0.0369)		0.0111 (0.1121)
Constant	-0.0589* (0.0329)	-0.189 (0.118)		
Observations	312	312	312	312
R-squared	0.669	0.670	0.602	0.604

Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

Risk attitude, as defined before, has statistically significant positive effect on compliance; while age has a positive effect but statistically insignificant, and sex has a negative and statically insignificant effect on compliance. Major in tax has a positive effect on compliance, though not statistically significant. The insignificance effect of age may be due to structural attributes in terms of age distribution of the University students; they are almost in the same age group due to the education system. However, the results according to age attribute can be different under field setting where significant variability in age, which may influence compliance behaviour, can be observed. As it has been in the previous empirical findings with regards the effect of gender on tax compliance are still not coinciding. D'Attoma *et al* (2017), for instance, found no significance difference in compliance by gender, while Yimam and Asmare (2020) in a study on firm level tax compliance in Ethiopia

established that female firm owners are likely to be more tax compliant relatively to male firm owner. In sum, the results presented here seem to suggest that the observed compliance differences between the control and treatment groups are largely as a result of the treatments than attributes of the participants. The observation of parameter estimates suggests that treatment 2 has higher impact than treatment 1.

5.3 Net revenue effect

The net revenue effect is computed as the difference between revenue increment due to lottery and the costs of administering the tax lotteries. The tax lotteries were designed such that their costs of administration are equal. Out of the five groups, two groups were control and three were treatment groups. Thus, the cost of a tax lottery is a fixed amount of Shillings 20,000. Taking compliance in the control group as a baseline scenario, we estimated the potential incremental tax revenue of the tax lotteries. The estimates of simulated tax revenue for the entire population based on compliance levels due to the two lotteries are as provided in Table 4.

Table 4: Computation of incremental tax revenue

Group	Obs.	Compliance (% of taxpayers)	Tax collected in a group	Total tax (simulated for the population)	Incremental tax
Control	126	69.84	87,998.40	218,599.20	-
Treatment 1	72	81.94	58,996.80	256,472.20	37,873.00
Treatment 2	115	85.22	98,003.00	266,738.60	48,139.40

Source: Author's computation

As shown, the results show that both lottery designs have net positive revenue increments. However, lottery design of low probability and high rewards has more revenue increment than lottery design of high probability and low rewards. The estimated difference in net revenue between these designs is about 27 percent. The findings that lotteries of high rewards are more attractive are corroborated with the findings from other empirical studies, which showed that a low probability and high rewards designs are more emotionally and attractive for consumers (see Perez and Humphreys, 2013; Brockman et al., 2016). Even though, in this study we propose a combination of the both lotteries as observed that each lottery sends a different signal to the different income categories of taxpayers.

5. Summary and implications

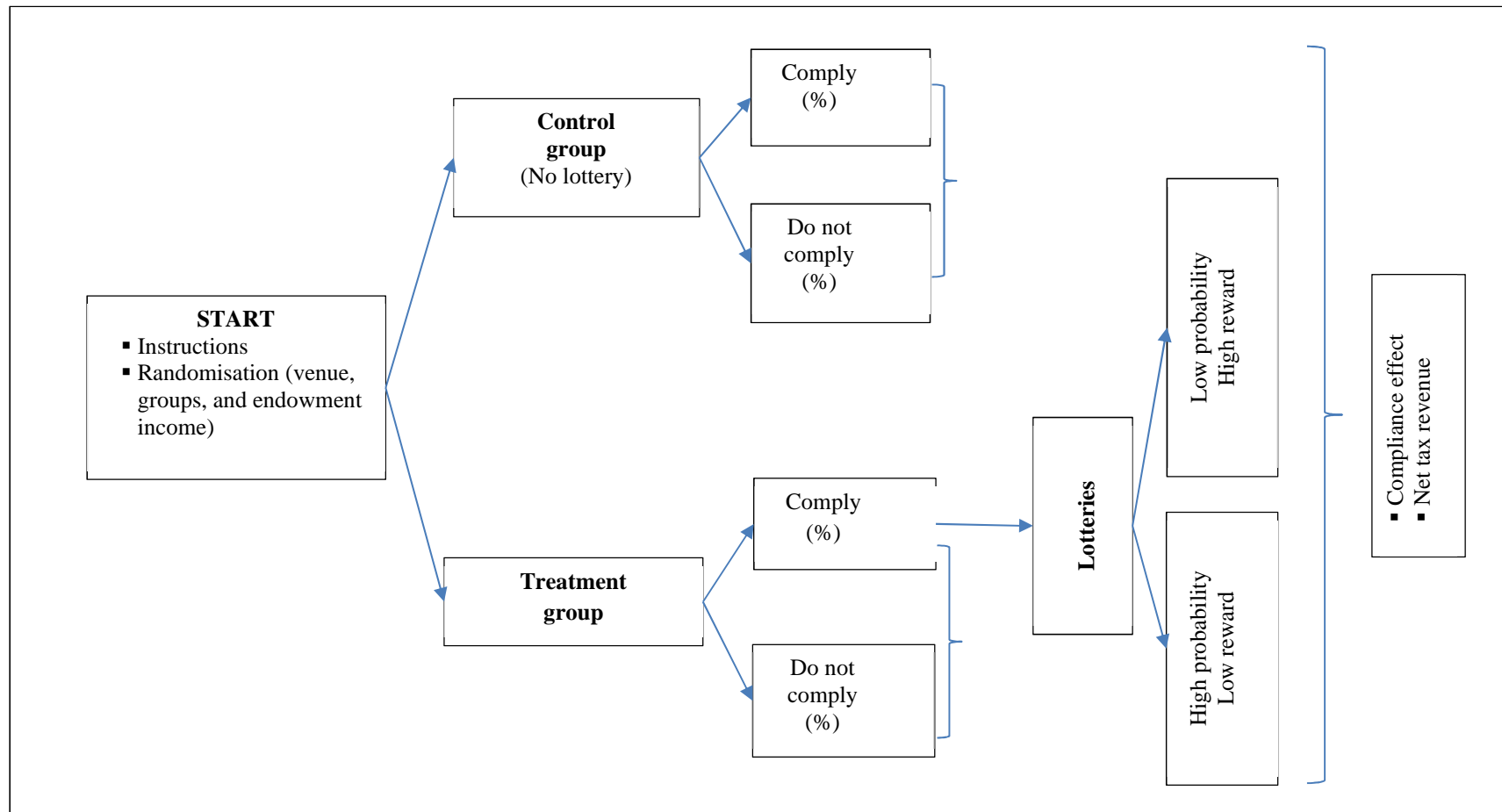
This study employed a lab experiment design to analyze the impact of tax lottery design on tax compliance and revenue. The results revealed that a lottery of a high rewards and low probability has a higher net tax revenue as compared to a lottery of low rewards and high probability, and the difference in net tax revenue is about 27 percent. Nevertheless, both designs had positive net tax revenue effect. Therefore, the implications of the study are that the design of a tax lottery is important in order to enhance the compliance and revenue impact. Also, there is potential for SSA to enhance compliance and revenue by implementing tax receipts lotteries.

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Annex 1: Schematic Presentation of the Experiment Design

Source: Authors' construction

Annex 2: Specific experiment instructions**(a): Control group (left panel), treatment 1 (middle) and treatment 2 (right)**

<p>Participant ID: _____</p> <p>From the endowment income provided, you are free to choose to buy food at a price with tax (5,000) or without tax (4,000). Tax collected will be donated to the student organisation to support its activities.</p> <p>Do you wish to pay tax? (Please tick appropriate box)</p> <p>Yes () No ()</p>	<p>Participant ID: _____</p> <p>From the endowment income provided, you are free to choose to pay for food at a price with tax (5,000) or without tax (4,000). Tax collected will be donated to the student organisation to support its activities. If you choose to pay tax you will be registered for a lottery which five persons will be picked random and rewarded Shillings 4,000 each.</p> <p>Do you wish to pay tax and register for a lottery? (Please tick appropriate box)</p> <p>Yes () No ()</p>	<p>Participant ID: _____</p> <p>From the endowment income provided, you are free to choose to pay for food at a price with tax (5,000) or without tax (4,000). Tax collected will be donated to the student organisation to support its activities. If you choose to pay tax you will be registered for a lottery which one person will be picked random and rewarded Shillings 20,000.</p> <p>Do you wish to pay tax and register for a lottery? (Please tick appropriate box)</p> <p>Yes () No ()</p>
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(b): Tax and net income declaration

<p>Participant ID: _____</p> <p>Date: _____</p> <p>Venue: _____</p> <p>Show up fee: <u>5,000</u></p> <p>Add endowment: _____</p> <p>Add winning: _____</p> <p>Total (A) _____</p> <p>Minus Tax (B) _____</p> <p>Net income (A-B) _____</p>
