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Faculty of Social Sciences
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BACHELOR THESIS

The VAT lottery as a charitable lottery

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Declaration of Authorship

The author hereby declares that she compiled this thesis independently, using only the listed resources and literature.

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Signature

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Abstract

This thesis consists of two main parts. At first, VAT lotteries are modelled as charitable lotteries for a public good. For that purpose, an economy consisting of risk-neutral, utility maximizing consumers with quasi-linear preferences is assumed. It is shown that the Taiwanese and the Slovakian versions of the VAT lottery provide more of the public good than an economy with no such lottery. The second part analyzes the willingness of firms and consumers to cheat and keep part of the VAT revenue for themselves. This is done because the key difference between the VAT and the charitable lotteries is the existence of firms which have an incentive to cheat and collude with the customers at the expense of the tax office. So when a set of profit maximizing firms is added to the model and the presence of the VAT lottery is still assumed, it is shown that under certain circumstances it might be more profitable for firms and customers to cheat because higher levels of profit or utility, respectively, might be achieved.

JEL Classification	H25, H41, D62, H26
Keywords	VAT, charitable lottery, public good, VAT evasion

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Abstrakt

Táto práca pozostáva z dvoch hlavných častí. V prvej časti modelujeme bločkové lotérie na spôsob charitatívnych lotérií, ktoré môžu byť využité na financovanie verejného statku. Z toho dôvodu analyzujeme systém, ktorý pozostáva zo skupiny spotrebiteľov, ktorí sa snažia maximalizovať vlastný úžitok, majú kvázilinárne preferencie a neutrálny postoj k riziku. Analýza ukazuje, že zavedenie taiwanského alebo slovenského modelu bločkovej lotérie zvyšuje celkový objem verejného statku, ktorý môže byť poskytnutý občanom. Druhá časť analyzuje motiváciu firiem a spotrebiteľov podvádzať a nezaplatiť celý objem DPH štátu. Hlavný rozdiel medzi bločkovou a charitatívnou lotériou je totiž ten, že bločkové lotérie rátajú s existenciou firiem. Tie majú možnosť podvádzať a spolupracovať so zákazníkmi na úkor daňového úradu. Ak teda rozšírime pôvodný model o skupinu firiem, ktoré sa snažia maximalizovať svoj zisk a predpokladáme existenciu bločkovej lotérie, potom za určitých okolností môže byť pre firmy a spotrebiteľov výhodnejšie podvádzať, pretože ich vlastný zisk, respektívne úžitok, môže vzrásť.

Klasifikácia JEL	H25, H41, D62, H26
Kľúčové slová	DPH, charitatívna lotéria, verejný statok, daňové úniky na DPH

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Acronyms

FOC First-order condition

IFP Institute for Financial Policy

R.O.C Republic of China

VAT Value-added tax

TIPOS Slovakian national lottery company

Bachelor Thesis Proposal

Author	Veronika Horváthová
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Proposed topic	The VAT lottery as a charitable lottery

Topic characteristics

As Slovakia's state budget suffers from a growing deficit, policy makers look for effective ways to alter the development of the situation. One strategy created by the government wants to decrease tax evasion by introducing a lottery. Every customer that pays VAT gains an opportunity to participate in a state-run lottery and every sales receipt may be converted into a lottery ticket. It is expected that businesses will be forced to pay the whole amount of VAT to the exchequer. The expectations are high because this type of lottery has existed for more than 50 years in Taiwan and its effects are remarkable. But from the theoretical point of view this lottery still is a pretty unexplored phenomenon.

The goal of this thesis is to compare a model of a VAT lottery and its real-life effects with a model of a charitable lottery and its implications. Another part of the thesis will analyze the consumers' and firms' behaviour and it will try to answer the question, whether this type of lottery has a chance to be successful. In particular, whether it can help to reduce tax evasion and even increase the total welfare or not.

Key questions

1. Why and how can VAT lotteries help to reduce tax evasion?
2. Is the model of the charitable lottery a good approximation of the VAT lottery in Slovakia or Taiwan?
3. Are consumers motivated enough to participate in the lottery and demand more sales receipts?

4. Are firms motivated enough to issue more sales receipts and pay the whole amount of tax collected?

Methodology

Microeconomic model of the VAT lottery as a charitable lottery
Microeconomic models of consumer's and firm's decision making

Outline

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Author Supervisor

Chapter 1

Introduction

The main subject of this thesis is the concept of VAT lotteries. The basic idea is that customers can win prizes just for the fact that they pay the VAT to the seller that is supposed to pay it to the tax office hereafter. Sales receipts are converted into lottery tickets because they serve as proofs that the VAT has been paid off to the seller. Many different types of lotteries have been around for many centuries and a lot of them are run by states, used to finance the public good. The concept of the VAT lottery is just one of many alternative ways how to boost tax compliance and thus funding of the public goods. So why is it worth to analyze exactly this special type of raffle?

First of all, there is strong empirical evidence that these lotteries do increase the motivation of customers and firms to pay greater fraction of taxes due to the tax office. The first data also show that state control mechanisms are more efficient in finding agents that do cheat and keep part of the tax revenue for themselves. More information about empirical data can be found in Wan (2010) that analyzed the Chinese VAT lottery or IFP (2014) that analyzed mainly the Slovakian VAT lottery. However, the first country in the modern history that introduced the concept of the VAT lottery was not China or Slovakia, it was Taiwan in 1951. And even though that the concept of the VAT lottery itself has been known for more than 60 years now, very little theoretical research has been conducted in this particular field so far.

In this thesis VAT lotteries are compared to charitable lotteries. The research is mostly based on the theoretical analysis from Morgan (2000). He examines lotteries as fund-raising instruments that are used by charities or other organizations. These institutions do not have any tax power, hence, they must rely on funding that consists of voluntary contributions of individuals in the economy. These funds are often used to finance some special types of public good. However, the problem in this case is extreme free-riding. Since individuals can decide how much they are willing to contribute, their contributions are often lower than what the socially optimal contributions would be. These individuals simply believe that other participants will provide enough money for funding anyway. As a result, the level of the public good is definitely smaller than the first-best level. In very extreme case, some socially desirable public goods might go entirely unfunded. More about that can be found in Bergstrom, Blume and Varian (1986) for example. Morgan (2000) showed that fixed-prize raffles can provide higher level of the public good, assuming that individuals have quasi-linear preferences and are risk-neutral utility maximizers. Hence, the total level of the public good provided by a fixed-prize raffle is closer to the socially optimal level. The gap between the provided and socially optimal level depends mainly on the value of the prize. If the prize is large enough, the level of the provided public good can be very close to the socially optimal level. The presence of the lottery also helps to alleviate the free-rider problem since more people are motivated to contribute to the public good because they want to win the prize. To sum up, fixed-prize charitable lotteries are a more efficient means of funding than the funding model based on voluntary contributions. However, the question is, how are VAT lotteries related to the charitable lotteries?

Governments always try to find new policies that would yield higher tax revenues. The intuition behind this type of lottery is that since charitable lotteries can increase the funding of some institutions, they should be capable of increasing the tax revenue, too. Basically, there are two problems that can be addressed by a VAT lottery. One of them is that such lottery might yield higher contributions to the public good because more purchases will be made. If the models of the charitable and VAT lottery were identical and modelled under the same set of assumptions, then it would be natural to expect that the effects of the VAT lottery are the same as the effects of the charitable lotteries. Hence, higher level of the public good would be provided since the tax revenue would increase. Another point of view is that the problem of the tax evasion might be partially solved if the VAT lottery is introduced. Some firms may decide to pay smaller amounts of VAT than are accounted for in the books of accounts of given firms. The VAT lottery is unable to solve this case. However, some firms do not account for all transactions that are made into the books of accounts because they want to keep part of the tax revenue. They might cheat alone or cooperate with customers and compensate them for their willingness to cheat. By the term cooperation is meant that customers do not demand sales receipts because without the receipts and entries in the books of accounts, then there are no proofs that such transactions happened. Nevertheless, the tax office is able to collect just the amounts of VAT that are recorded in the books of accounts. And since the data in these books underestimate the real amount of VAT that should be paid to the tax office, the total level of the public good is then lower than what it would have been if the whole amount of VAT was collected. The presence of the lottery creates new motivation for customers to ask for sales receipts since these might serve as lottery tickets later on. Hence, if more sales receipt are demanded when the lottery is present, firms will have a smaller amount of opportunities to cheat. Also, if firms issue illegal sales receipts to customers and they do not pay the VAT afterwards, they face higher probability of being caught because they never know which sales receipts will participate in the lottery after all. As a result, the risk of being caught when cheating increases when the lottery is present. That should motivate firms to pay the whole amount of VAT to the tax office.

The objective of this thesis is to analyze the concept of the VAT lottery from the same perspective as Morgan (2000) analyzed the concept of charitable lotteries. The next step is to enlarge the analysis since the decision making process of firms is also taken into account and analyzed throughout the second half of this thesis. This is done to explain why cheating and collusive behaviour might be found rational under certain circumstances and what might decrease the motivation to cheat.

This thesis comprises of the following parts: Chapter 2 describes how lotteries are in Taiwan, Slovakia and a few other countries designed. Chapter 3 introduces the theoretical models of the lotteries of Taiwan and Slovakia. Chapter 4 discusses other factors that may affect whether it is profitable to run a VAT lottery in a given country. Chapter 5 introduces the firms' sector to the model and tries to explain decision making process of firms. The firms' and consumers' motivation to cheat is also largely discussed in this section. Finally, Chapter 6 contains a brief overview of the most important conclusions.

Chapter 2

When invoicing becomes a lottery

2.1 Taiwan

As it was already mentioned in the introduction, Taiwan was the very first country in the modern history that introduced a sales tax lottery. The Taiwanese government was searching for new policies that could increase the tax revenue during the first half of 20^{th} century. One of the proposed ideas was to create a VAT lottery. Since many transactions went undocumented at that time, the Taiwanese government wanted to create an incentive yielding increased amount of documented transactions. Therefore, customers that ask for sales receipts after purchases they make in shops or restaurants have the opportunity to participate in the state-run lottery and win cash prizes. The lottery was launched in 1951 and the first published results were astonishing. The amount of money collected by the tax office during the first year when the lottery was in operation increased by 76% (when compared to the previous year).

This lottery is in operation even after more than 60 years and it still is very popular in Taiwan. The Ministry of Finance of R.O.C. exerts great effort to keep it that way. For example, a new platform for e-invoices was launched a few years ago, in order to make the lottery not only eco-friendlier, but also participant-friendlier. The Ministry of Finance calculated that around 80,000 trees can be saved every year. That might be a very strategic step since Taiwan lacks natural resources. Also, it is easier to have all of the data about all transactions on one card than to keep hundreds of small sales receipts around all the time. But it is necessary to know more about the design of the lottery in order to fully understand reasons why it is so popular in Taiwan.

How does the lottery work?

The first step is to obtain a lottery ticket so one must make a purchase in a shop or in a restaurant and demand a sales receipt. No special registration of this sales receipt is required, all legally issued sales receipts can participate in the lottery automatically and are capable of winning.

A few important specifications are written on every sales receipt:

- one 8-digit number
- the month of the purchase
- the value of the purchase.

If one or more of the specifications are illegible, such sales receipt is considered to be invalid and cannot participate in the lottery. The month of the purchase is important because only sales receipts satisfying one special condition can attend the lottery. Lottery drawings are held on 25^{th} of every odd-numbered month (so they are held in January, March, May, July, September and November). The sales receipts capable of winning the lottery are the ones issued during the two months before the month in which the drawing is held. So for example, if the drawing is held on 25^{th} March, then the sales receipts included in the lottery are receipts issued during January and February of the same year.

Every odd-numbered month a list of 8-digit and 3-digit numbers is determined by a lot. More precisely, 5 different 8-digit numbers and 3 extra 3-digit numbers are determined at random. However, these amounts of determined combinations may vary for different months. The structure of prizes stays the same throughout all the rounds. The participants must compare these determined numbers with numbers on their sales receipts in order to see whether they possess a winning lottery ticket. If a 8-digit number written on the sales receipt matches one of the determined combinations in a way that is described in the Table 2.1, such sales receipt is considered to be the winning one and the owner of the sales receipt can collect the prize. Every lottery ticket can win at most once. The most important information about the prizes or amounts and types of winning combinations determined by a lot are also described in the Table 2.1, which can be found on the very next page.

Name	Prize	Winning number(s)	Ticket is winning
Special Prize	NT$10 million	8-digit number	when matching all digits from the Special prize number
Grand Prize	NT$2 million	8-digit number	when matching all digits from the Grand prize number
First Prize	NT$200,000	3x 8-digit number	when matching all digits from any of the First prize numbers
Second Prize	NT$40,000		when matching the last 7 digits from any of the First prize numbers
Third Prize	NT$10,000		when matching the last 6 digits from any of the First prize numbers
Fourth Prize	NT$4,000		when matching the last 5 digits from any of the First prize numbers
Fifth Prize	NT$1,000		when matching the last 4 digits from any of the First prize numbers
Sixth Prize	NT$200		when matching the last 3 digits from any of the First prize numbers
Additional Sixth Prize	NT$200	4x 3-digit number	when matching the last 3 digits from any of the First prize or Additional Sixth prize numbers

Table 2.1: Overview of the Taiwanese lottery

As it can be seen in the table, prizes range from NT$200, which is slightly less than €6 (around 160 CZK) up to NT$10 million, which is approximately €294,000 (more than 8 million CZK)[1]. For comparison, the average monthly wage in Taiwan is approximately NT$43,000 (around €1,200, alternatively 34,500 CZK) so the Special Prize is more than 230 times higher than the average salary in Taiwan. For a person that earns only the minimum wage (approximately NT$19,000) is the prize about 530 times higher than this wage.

Another reason why this lottery is so popular is that it is very easy to play. Moreover, it is not that difficult to compute the probabilities of winning. So imagine a random individual that possesses one lottery ticket with a random 8-

[1]Using exchange rate €1 = NT$33.942 = 27.424 CZK from 22.03.2015

digit number. The probability that this sales receipt wins the Special or Grand Prize is simply 1 to 100,000,000. More precisely, only one 8-digit combination is at disposal, it must match the winning combination that is determined by a lot and there are 10^8 different 8-digit numbers. Other probabilities of winning can be computed in the similar way. Following Table 2.2 provides an overview of all probabilities of winning.

Prize	Probability of having a winning ticket
NT$10 million	1 to 100,000,000
NT$2 million	1 to 100,000,000
NT$200,000	3 to 100,000,000 = 1 to 33,333,333.33
NT$40,000	3 to 10,000,000 = 1 to 3,333,333.33
NT$10,000	3 to 1,000,000 = 1 to 333,333.33
NT$4,000	3 to 100,000 = 1 to 33,333.33
NT$1,000	3 to 10,000 = 1 to 3,333.33
NT$200	7 to 1,000 = 1 to 142.86

Table 2.2: Probabilities of winning the Taiwanese lottery

Statistically speaking, individuals that collect 143 sales receipts with different final triplets are expected to win NT$200 in every single round. And it is not that difficult to gather 143 different sales receipts during that time frame. However, there is a risk that some of the final triplets might be iterative. Nevertheless, individuals that collect 143 sales tickets in two months collect 2.4 receipt a day on average. If they make a few trips to the grocery shops per week, visit a restaurant or purchase a book, have a cup of coffee or tea, they might gather 143 sales receipts pretty quickly. There is also a possibility to pay for every item separately and increase the amount of sales receipts considerably.

To sum up, one of the reasons why this lottery is so popular is the fact that one does not have to buy special lottery ticket in order to participate in the lottery. Also, no registration is required in order to play the game. The opportunity to win the prize is offered automatically, the only condition is that customers have to make a purchase as they usually do. In fact, the participation in the lottery does not cost the customers anything. The only cost on the side of the customers is that they have to actively demand sales receipts. Another important fact is that the chances of winning do not depend on decisions of other consumers and they are constant. Hence, the Taiwanese VAT lottery is really easy to understand and play.

What to do in case of having a winning ticket?

In case that someone is an owner of a winning receipt, this person must fill out the form that can be found on the back of the sales receipt and present it with the ID card at any post office in order to collect the prize. The winner does not have to collect the prize in person, somebody else can be entrusted to collect the money instead. 20% withholding tax is levied on all prizes except from the Additional Sixth, the Sixth and the Fifth prize. One interesting fact is that also foreigners can participate in this lottery and in case they possess a winning ticket, they have the right to collect the prize. But in case that the winner is a government agent, a state-run enterprise, a public school, a military unit or a business entity, the prize must not be paid out.

To conclude, this lottery has already existed for more than a half of the century and it still is very popular among people in Taiwan. Hence, it was not surprising that this concept became an inspiration for other countries in the world and many of them really launched their own version of VAT lotteries. One of such inspired countries is Slovakia.

2.2 Slovakia

A proposal that a similar model of the sales tax lottery can also help Slovakia was announced in the first half of 2013 by the Ministry of Finance of the Slovak Republic. The Slovakian government faced the problem of shrinking tax revenues. It was only a few years ago when the tax office was still able to collect approximately 80 percent of taxes due, nowadays it is just slightly above 60 percent. The tax office collected only €4.27 billion in VAT in 2012 and the Ministry of Finance estimated a gap equal to €2 billion. For that reason the government bustled up and the sales tax lottery was launched on 1^{st} September 2013. The very first drawing was held on 30^{th} September 2013.

Participation in the lottery

The Slovakian lottery differs from the Taiwanese one significantly. The main difference is that customers in Slovakia have to register sales receipts for the lottery. Hence, all sales receipts are not capable of winning automatically. There are many ways for customers to enroll receipts for the lottery. The first option is to register sales receipts via internet or via application in the smart phone and any sales receipt can be registered free of charge. Attendees are just asked to create a free account. Another way is to register them via text message. However, a service fee is charged for every text message that is sent. The main disadvantage is that the participants can register only one sales receipt via one text message so it might be pretty expensive to register greater amounts of sales receipts for the lottery. The third option is to visit one of the branch offices of TIPOS and register the sales receipts there, but the registration of one sales receipt costs 20 cents. The last option is to register the receipt directly via electronic cash registers in partner shops of TIPOS and this is done for free in some shops or for a small service fee in others.

The registration requires that a few control specifications must be inserted into the database. More precisely,

- the tax code of the cash register, which is a 16- or 17-digit number unique for every cash register in the country
- the date and the time of the purchase
- the value of the purchase.

But all specifications can be easily found on any sales receipt. When registering one sales receipt into the lottery, a computer will immediately signalize whether an invalid sales receipt has been obtained. Any sales receipt with the spurious tax code of the cash register might be reported to the Financial Administration and the shop possessing this cash register has to be controlled. After the registration, attendee obtains a registration code and a verification code, which are unique codes for every registered sales receipt. When one's registration code is determined by a lot, the winner must show the corresponding verification code in order to collect the prize.

Toss up and winnings

Up to this day, two different models of the lottery have been in operation. The first one operated for a year (from September 2013 to September 2014) and now the second version is still in operation. The first version of the lottery consisted of three independent parts and they were called the First, the Second and the Third chance. The First chance and the Second chance operated from the beginning of September 2013, the Third chance was introduced in December 2013. Every sales receipt had an opportunity to participate in all parts of the lottery, but it could be included just once in the drawing of every chance. Participation in the First chance and the Second chance was automatic after the registration. However, if a participant wanted to enroll a sales receipt for the Third chance as well, another registration was required. Every participant had to send one more text message (the text of this message was the registration code of one already registered sales receipt) in order to be included in the toss up for the Third chance. The service fee charged for every message was 50 cents.

The drawing of the First chance was held once in 14 days. All registered sales receipts issued during the two months before the day of the drawing were included in the drawing. 10 registration codes were determined by a lot in every toss up. The participants were able to win 10 cash prizes that ranged from €100 up to €10,000. The drawing of the Second chance was held once in 28 days. 8 tax codes of the cash registers were determined by a lot in every round, one for every county. Then all registered sales receipts issued during the 2 months before the day of the toss up with the congruent tax code of the cash register were included in the lottery. One winning registration code was determined by a lot for every county. All winners gained €5,000. The drawing of the Third chance was held once in 28 days, as well. From all specially registered registration codes, 150 were determined by a lot. The winners gained an opportunity to attend the recording of the TV show "The Price Is Right" (and possibility to win some cash or non-cash prizes). Out of the 150 show participants, one was determined by a lot and the winner gained cash prize up to €10,000 plus extra non-cash prize.

The new and much more simplified model of the lottery has been in operation since September 2014. It still holds that only sales receipts that were issued during the two months before the day of the drawing are included in the drawings. But, the First chance and the Second chance were merged together into one drawing, which is now held every week and 100 winning registration codes are determined by a lot. Winners gain €100 for every winning ticket. Another change is that Jackpot has been created and one registration code out of all registration codes is determined by a lot every week. The Jackpot for a given week is created in the following way: TIPOS puts 1 cent for every registered sales receipt into the prize pool and after a week the drawing is held. One registration code is determined to be the winning one and 70% of the value of the Jackpot is paid off to the winner whereas the remaining 30%

creates the base prize pool of the next week's Jackpot. The value of the first Jackpot was equal to €12,844.15 (which is approximately 350,000 CZK), the value of the second one was slightly above €12,000 (330,000 CZK) and then the value of the Jackpot stabilized somewhere around €9,000 (246,000 CZK) during December 2014 and January 2015. The average monthly wage in Slovakia[2] is equal to €858, the value of the Jackpot is therefore about ten times higher than the average wage. The minimum monthly wage is equal to €380, hence the Jackpot is approximately 23 times higher.

The Third chance stayed in operation as it was before, but the name has changed, now it is called the TV chance. Only the sales receipts that were issued during the two months before the day of the drawing are included in the drawing. Nevertheless, a special registration of the already registered sales receipts is still required. Only 80 registration codes are determined by a lot (compared to the Third chance where 150 registration codes were determined by a lot). The owners of the winning sales receipts can attend the recording of the TV show "The Prize Is Right" and possibly win some cash or non-cash prizes. Four of the participants in the audience are determined by a lot and they win some special prize.

After all, if consumers want to register sales receipts for the lottery, they have many different ways how to do it at disposal. But it is really interesting that every option costs a different amount of money. This can be really confusing for the participants and their motivation to take part in the lottery can depend on that highly. Maybe some consumers do not have the opportunity to register the sales receipts free of charge and then the total costs for the registration might be very high. For comparison, the Taiwanese lottery does not require any registration. Another cost is the time that consumers have to spend if they want to participate in the lottery. Writing all the information into the database might be tedious. The next point is that the concept of the lottery in Slovakia is much more complicated than the one in Taiwan - a registration of every receipt is required, extra registration for the Third chance is necessary, the way how the Jackpot is created. Also it is harder to calculate the probabilities of winning because they depend on the decisions of all participants. The following

[2] The average wage for the the year 2014, Statistical Office of the Slovak Republic.

term expresses the probability of a random registered sales receipt to win €100

$$p(win) = \frac{\binom{a(N)-1}{99}}{\binom{a(N)}{100}} = \frac{100}{a(N)},$$

where $a(N)$ stands for all registered sales receipts for one round. The probability of a random ticket to win the Jackpot is simply $1/a(N)$. If a sales receipt is registered for the TV chance, then the probability that the given sales receipt is the chosen one is equal to

$$p(win) = \frac{\binom{b(N)-1}{79}}{\binom{b(N)}{80}} = \frac{80}{b(N)},$$

where $b(N)$ stands for the total amount of sales tickets registered for the TV chance (assuming $b(N) \leq a(N)$). Since these probabilities depend on the total amount of registered tickets, it is a little bit harder to play the Slovakian lottery. The participants of the Taiwanese lottery do not have to account for the decisions of others participants. The expected win is constant for all sales receipts and therefore the motivation to ask for one more sales receipt is constant as well. On the other hand, the participants of the Slovakian lottery have to account for the decisions made by all other participants. Hence, all participants face diminishing increase in the probability of winning and their motivation to register one more sales receipt diminishes when the total amount of registered sales receipts increases at the same time.

How to collect winnings?

Every winner must at first show the corresponding verification code in order to collect the prize. Smaller prizes can be brought forward to one's bank account or paid out at one of the branch offices of TIPOS. Higher amounts of money may be paid out only at the domicile of TIPOS. And government prepared one more surprise; prizes are tax-exempt in this lottery.

This was just a quick comparison of the two models from Taiwan and Slovakia. The theoretical models of both of them are introduced in the following chapter. Interestingly enough, there are many other countries in the world that have been operating or operated their own versions of the sales tax lottery; for example China, Malta, Georgia or Portugal. Their lottery designs are described shortly below.

2.3 Other examples of VAT lotteries

2.3.1 China

The Chinese VAT lottery was firstly introduced on 4^{th} March 1989 as an experiment, which was supposed to be held in some areas. That would allow the economists to compare results from areas with and without a lottery at the same time. This experiment eventually came into life and the sales tax lottery was launched on 1^{st} January 1998 in Haikou City, Hainan Province. 12% of the local tax offices were conducting this type of lottery by the end of 2002. The cash registers that are included in the experiment have been issuing special type of scratch-and-win receipt called *fapiao* and it serves as a sales receipt and a lottery ticket simultaneously. A special hidden number that can be scratched away is incorporated into this *fapiao* and customers can win from 5 to 50,000 CNY (from €0.74 to €7,492.42)[3]. This lottery has been analyzed narrowly by a Chinese researcher Junmin Wan[4]. According to his research, this lottery has been a successful experiment, because the total input to output ratio was approximately 1:30 (30 million Yuan was the total prize amount paid off to the participants of the lottery and increase in the tax revenue was equal to 900 million during the first half of 2002). The total operating tax revenue was significantly higher (by 17.1%) in the experimental areas.

2.3.2 Malta

Also this country surrounded by the Mediterranean Sea has been operating the VAT lottery for more than 10 years. Every sales receipt can be converted into a lottery ticket. The participants must write their full name, ID card number and telephone number on the back side of every receipt that is supposed to be registered for the lottery and send them to the Department of Public Lotto in Valetta. The winners gain centuple of paid VAT back. However, the minimum guaranteed prize is €233 and the maximum prize is €11,647. The drawing is held every month and all received receipts issued during the previous month are included in the drawing.

[3]Using exchange rate €1 = 6.73 CNY from 22.03.2015
[4]For more information see Wan (2006) or Wan (2010).

2.3.3 Georgia

Georgia launched its own version of the VAT lottery on 18^{th} April 2012. However, this lottery had not been in operation for a long time. It was canceled after seven months, due to a low impact on the tax revenue. All sales receipts were automatically included in the lottery. The drawing was held every day and the prizes ranged from 10 GEL (€4.15) to 50,000 GEL (€20,746.89)[5].

2.3.4 Portugal

Since April 2014, all citizens are able to participate in the Portuguese lottery and win a luxury car (worth around €90,000). The drawing is held every week plus some extra drawings are held throughout the year (for example before Christmas). In total, around 60 cars are prepared for the winners of the lottery. Sales receipts that participate in the lottery must include the purchaser's unique personal tax identification number (which can be issued for every purchaser by the tax office). Every authentic sales receipt is then converted into coupons which consequently attend the lottery. Sales receipts that worth up to €10 are converted into one coupon, sales receipts that worth up to €20 are converted into two coupons and so on. Every week one coupon is determined by a lot. The effects of this lottery are not known yet, due to the small amount of data.

[5] Using exchange rate €1 = 2.41 GEL from 22.03.2015

Chapter 3

Theoretical models of the lotteries

As it was already mentioned in the Introduction, the existing VAT lotteries have not been modelled and explained from the theoretical point of view yet, even though that many different versions of the VAT lottery have been in operation in many countries and for many years. Empirical evidence suggests that there might be a positive effect on the total tax revenue (for more information see Wan (2010) and his research based on the data collected in China). In this chapter only the Taiwanese lottery and the Slovakian lottery are analyzed and compared to the model of the charitable lottery described by Morgan (2000). The main purpose of this chapter is to find out whether it is possible to analyze the VAT lotteries in a similar way as Morgan (2000) analyzes charitable lotteries.

3.1 Preliminaries

Environment

Assume an economy that consists of n individuals ($n \in \mathbb{N}$) that are risk-neutral, non-altruistic and they want to maximize their own utility. Their preferences can be described by quasi-linear utility functions of the form

$$U_i = w_i + h_i(G, x_i);\ i \in \{1, 2, ..., n\},$$

where w_i represents a numeraire good that denotes the disposable income of the i^{th} individual. G represents the level of the public good that is provided by the government and suppose that the public good is socially desirable ($G \in \mathbb{R}_+$). Then, x_i denotes the level of the private good possessed by the i^{th} individual.

All individuals experience diminishing marginal utility from the increasing level of the private and the public good, therefore

$$\frac{\partial h_i(.)}{\partial G} > 0 \quad and \quad \frac{\partial^2 h_i(.)}{\partial G^2} < 0;\ \forall i \in \{1, 2, ..., n\};$$

$$\frac{\partial h_i(.)}{\partial x_i} > 0 \quad and \quad \frac{\partial^2 h_i(.)}{\partial x_i^2} < 0;\ \forall i \in \{1, 2, ..., n\}.$$

Social optimum

The main task of the social planner is to maximize the total welfare in the economy by choosing the optimal level of the public good. Formally, that means to maximize

$$W = \sum_{i=1}^{n} \Big(w_i + h_i(G, x_i) \Big) - G,$$

where $G \leq \sum_{i=1}^{n} w_i$. It is possible to calculate the optimal amount of the public good that should be provided by the government by taking derivative of the total welfare function with respect to G. For the optimal level of the socially desirable public good (G^*) must hold the following condition:

$$\sum_{i=1}^{n} \frac{\partial h_i}{\partial G}(G^*, x_i) = 1;\ G^* \in \mathbb{R}_+.$$

This condition is known as the Samuelson Criterion for the welfare maximization. If the optimal amount of the public good is less or equal to zero, such public good is called *socially undesirable* and it is not provided by the state.

So far, all assumptions stated in this model are the same as the set of assumptions used by Morgan (2000). The only change is that the existence of the private good must be assumed as well. The reason is that consumers do not contribute to the public good directly. Their total contribution to the public good depends on the private consumption since the VAT is levied on the private consumption of goods and services. Hence, the optimal levels of the private and public good depend on each other when assuming the existence of the VAT. But this model is consistent with the model from Morgan (2000) as far as the preferences of the consumers are described by quasi-linear utility functions.

Model with the VAT

It is a well known fact that the numeraire good can be transformed into the private good. And suppose that a value-added tax with a tax rate equal to τ (τ can take values between zero and one) is levied on the consumption of goods and services. In that case only $(1-\tau)$-part of the value of the purchase is transformed into the private good and the rest is transformed into the public good. Hence, by a term purchase is understood an operation when 1 unit of the numeraire good is spent on the purchase of the private good, but increase in x_i is only equal to $(1-\tau)$. Therefore there is a simultaneous increase in the level of the public good by τ. The preferences of all consumers can be described by the utility functions of the form

$$U_i = w_i - a_i + h_i\Bigg(\tau a(N), (1-\tau)a_i\Bigg),$$

where a_i is the amount of purchases made by the i^{th} individual. For the amounts of purchases must be true that $\forall i \in \{1, 2, ..., n\}: \ a_i \in [0; w_i], \ a_i \in \mathbb{N}$. Then, $a(N)$ is the sum of all purchases made by all consumers together. Formally, $a(N) = \sum_{i=1}^{n} a_i$. The level of the public good G can be expressed as $G = \tau a(N)$ because that is the total tax revenue collected by the tax office (assuming that the whole tax revenue can be transformed into the public good). From the last equation it can be seen that the function $h_i(.)$ depends only on one variable a_i, given the amounts of purchases of all other consumers. Therefore it is possible to define a new function $\theta_i(a_i)$ as

$$\theta_i(a_i) = h_i\Bigg(\tau a(N), (1-\tau)a_i\Bigg).$$

This function has the same properties as function $h_i(.)$; hence, it is increasing on the $[0; w_i]$ with diminishing marginal returns to scale.

Optimum

Given the amount of the purchases of all other consumers and assuming that wealth constraints are non-binding for all individuals, then there exists an interior solution (because given utility functions are strictly concave on a compact set) of the following optimization problem

$$\underset{a_i}{max}\ U_i(a_i); \quad s.t.\ a_i \in [0, w_i] \quad \forall i \in \{1, 2, ..., n\}.$$

A Nash equilibrium is then defined as the n-tuple $(a_1^*, a_2^*, ..., a_n^*)$ of the amounts of purchases and this n-tuple solves the optimization problem stated above. The level of the public good provided is equal to $G^* = \tau\big(\sum_{j=1}^{n} a_j^*\big)$.

Even though it is possible to compute the expected amount of money that should have been collected by the tax office during a certain period of time (assuming that the tax office knows the preferences of the individuals), data shows that many countries are inefficient in this tax collection and are not able to collect the whole amount of taxes due. Assuming that the tax office can collect the whole amount of the VAT that is accounted for in books of accounts, that means that the reported amounts of purchases (a_i^r) and the expected optimal amounts of purchases (a_i^*) differ. Or, in other words, the real tax revenue is equal to $\tau\big(\sum_{j=1}^{n} a_j^r\big)$ and it is smaller than the expected revenue, so $\forall i \in \{1, 2, ..., n\};\ a_i^r \leq a_i^*$. This also implies that the level of the public good is underprovided when compared to the expected level of the public good. The goal of the lottery is to increase the total reported amounts of purchases in order to increase the tax revenue. The main question therefore is: Is the VAT lottery theoretically able to increase the total reported amounts of purchases when a prize for equitable taxpayers is introduced?

3.2 Taiwan

The Taiwanese lottery is a type of a multiple-prize lottery, as it was described in the previous chapter. At first, it is easier to model the lottery under the assumption that only one fixed prize equal to R $(R \in \mathbb{R}_+)$ is introduced to the public. The model of the multiple-prize lottery is discussed afterwards.

3.2.1 Single-prize lottery

As it was already discussed in the previous chapter, the probability of winning does not depend on the amounts of lottery tickets possessed by all other individuals, because this probability of winning is just a fixed number (denoted by π later on). Therefore, the probability of winning of the i^{th} individual is simply equal to $a_i\pi$, assuming that all customers obtain sales receipts for all purchases they make and all sales receipts are converted into lottery tickets. It is also assumed that one individual does not possess two or more lottery tickets with the same combination.

Another assumption is that the lottery should be capable of financing itself. At first, the value of the prize must be subtracted from the total amount of money collected by the tax office and the rest of the tax revenue is transformed into the public good. However, it is impossible to say how many prizes will have to be paid off in a given round of the Taiwanese lottery. It might happen that none of the issued sales receipts matches the winning combination and therefore the whole amount of money collected by a tax office can be transformed into the public good. Another alternative is that two or possibly even more sales receipts match the winning number. This situation is plausible because the total amount of sales receipts issued during any two months is much higher than the total amount of combinations of a 8-digit number. Hence, it is not known before the toss up whether the lottery will be capable of financing itself.

Even though it is impossible to know the exact amount of money that will have to be paid off beforehand, it is possible to create a decent estimate of that amount. The expected amount of winning tickets for one round can be calculated using a simple statistical approach. Consequently, the expected amount of money that will have to be paid off in a given round can be obtained. This can be used as a good approximation of the total amount of money spent on prizes in one round. So, from the statistical point of view, the expected amount of winning tickets in one round is equal to $\pi a(N)$. Hence, the expected level of the public good is equal to

$$G = \tau a(N) - \pi a(N)R = (\tau - \pi R)a(N).$$

From the last term it can be seen that the necessary condition that needs be fulfilled is that $(\tau - \pi R) \geq 0$. If this condition was not satisfied, the lottery would not be able to finance itself implying that it would have to be subsidized by the government. Such model of the lottery would be very inconvenient, because it would not help to solve the problem the government has been facing.

Putting all the new information into the utility function, every individual tries to maximize the utility function of the form:

$$EU_i = w_i - a_i + h_i\Big((\tau - \pi R)a(N), (1-\tau)a_i\Big) + a_i\pi R.$$

Again, function $h_i(.)$ is a function of only one parameter a_i and therefore the notation from the previous section can be used:

$$\theta_i(a_i) = h_i\Big((\tau - \pi R)a(N), (1-\tau)a_i\Big).$$

Differentiating with respect to a_i yields the set of first-order conditions of the form

$$\frac{dEU_i}{da_i} = -1 + \theta_i'(a_i) + \pi R \leq 0.$$

Given that the set of assumptions is the same as in Morgan (2000), then it is possible to model the one-prize VAT lottery as a charitable lottery and therefore the results described in his paper do hold for this lottery, too. More precisely, Morgan (2000) proved that when the preferences are quasi-linear, the fixed-prize charitable lottery has a unique equilibrium and the level of the public good provided is higher when the lottery is present. Hence, when the consumers have quasi-linear preferences, then the fixed-prize VAT lottery has a unique equilibrium as well. And since the preferences are quasi-linear, the fixed-prize VAT lottery yields higher level of $a(N)$. Hence, the total level of the public good increases as well, because the level of the public good is linearly dependent on the total amount of purchases, since $G = (\tau - \pi R)a(N)$. So theoretically, the fixed-prize VAT lottery partially solves the problem and yields higher tax revenue for the government.

3.2.2 Multiple-prize lottery

So far only the existence of one prize has been assumed. But, the Taiwanese lottery is a type of multiple-prize lottery (the overview of prizes can be found in Chapter 2, Table 2.1). So in reality, 9 different prize categories exist. Formally, suppose that m different prize categories are introduced to the public ($m \in \mathbb{N}$) and denote them as R_z where $z \in \{1, 2, ..., m\}$. The probabilities of winning can be also found in Chapter 2, Table 2.2. As it can be seen, all probabilities of winning are just fixed numbers; hence, they can be denoted as π_z where again $z \in \{1, 2, ..., m\}$. The expected amounts of prizes that will have to be paid out in the given round are calculated in the same way as before when only one prize was introduced. The total amount of the public good provided in this case is therefore equal to

$$G = \tau a(N) - \sum_{z=1}^{m} \big(\pi_z a(N) R_z\big) = \Big(\tau - \sum_{z=1}^{m} (\pi_z R_z)\Big) a(N).$$

The necessary condition that must be fulfilled is

$$\tau - \sum_{j=1}^{m} (\pi_z R_z) \geq 0.$$

Again, if this condition did not hold, the lottery would not be able to finance itself and the government would have to subsidize the lottery. As a result, such lottery would not be able to provide more of the total tax revenue and would not solve the problem the government has been facing.

Now, the form of the utility function of consumers changes, but at first the expected win in one round has to be calculated. Assuming that all lottery tickets of the i^{th} individual differ from one another[1], the expected win in this case is equal to

$$E_i(win) = \sum_{z=1}^{m} (a_i \pi_z R_z) = a_i \sum_{z=1}^{m} (\pi_z R_z).$$

Therefore the utility function of the i^{th} consumer looks as follows

$$EU_i = w_i - a_i + \theta_i(a_i) + a_i \sum_{z=1}^{m} (\pi_z R_z),$$

where

$$\theta_i(a_i) = h_i\bigg(\Big(\tau - \sum_{j=1}^{m} (\pi_z R_z)\Big) a(N), (1-\tau) a_i\bigg).$$

Differentiating with respect to a_i yields first-order conditions of the form

$$\frac{dEU_i}{da_i} = -1 + \theta_i'(a_i) + \sum_{z=1}^{m} (\pi_z R_z) \leq 0.$$

[1]This assumption is pretty restrictive when computing the expected win for prizes like the Sixth prize. The amount of different lottery tickets is then equal to 1000 since the sales receipt is considered to be the winning one if its final triplet matches any of the final triplets of the winning combinations. The higher the amount of digits individual has to match in order to win, the less restrictive this assumption becomes.

To conclude, this multiple-prize VAT lottery can be also modelled in a similar way as the fixed-prize charitable lottery is modelled by Morgan (2000), the same set of assumptions is used. Hence, the conclusions about the charitable lotteries do hold for this exact type of the VAT lottery, too. Therefore this multiple-prize lottery also provides more of the $a(N)$ and has a unique equilibrium, because the preferences are modelled by quasi-linear utility functions. Hence, the total tax revenue increases and a higher level of the public good can be provided.

3.3 Slovakia

The Slovakian lottery consists of three parts, as it was discussed in the previous chapter. Since these parts do not affect one another directly in the real lottery and they operate independently, it is possible to model every part of the lottery separately. It might happen that one lottery ticket is determined by a lot in more than one part of the lottery in the same round, but the probability that something like this really happens is pretty low so this fact will be ignored.

3.3.1 First chance

The first part of the lottery offers 100 prizes and every one of them is equal to €100. What that implies is that this part of the lottery is a type of the multiple-prize lottery. But again, it is better to model the fixed-prize VAT lottery that introduces only one fixed prize at first and then move to the model that introduces more prizes for the customers.

So firstly, suppose that there is only one fixed prize introduced and its value is equal to R. Secondly, suppose that consumers receive a sales receipt for every purchase they make and another assumption is that all receipts are registered and take part in the lottery. Then, the probability of winning for i^{th} individual, given the purchases of all other individuals a_{-i}, is equal to

$$\pi(a_i, a_{-i}) = \frac{a_i}{a(N)}.$$

Since a part of the tax revenue must be paid off to the customers in the form of prize R, only $\tau a(N) - R$ is transformed into the public good after all. And the necessary condition is that $\tau a(N) - R \geq 0$. The lottery would not be able to finance itself if this condition did not hold.

The form of the utility functions changes as well and now it looks as follows

$$EU_i = w_i - a_i + h_i\Big(\tau a(N) - R, (1-\tau)a_i\Big) + \frac{a_i}{a(N)}R.$$

Again, function $h_i(.)$ can be rewritten as

$$\theta_i(a_i) = h_i\Big(\tau a(N) - R, (1-\tau)a_i\Big).$$

Taking derivative with respect to a_i yields first-order conditions

$$\frac{dEU_i}{da_i} = -1 + \theta_i'(a_i) + \frac{a(N/i)}{a(N)^2}R \leq 0,$$

where $a(N/i)$ is the sum of all purchases made by all individuals except from the i^{th} individual. It can be seen that this part of the lottery has exactly the same structure as the fixed-prize charitable lottery analyzed by Morgan (2000). Anyway, the most important assumption still is that the preferences of all consumers are quasi-linear. Since this assumption is satisfied, the VAT lottery has a unique equilibrium and the level of $a(N)$ increases. Hence, the level of the public good that is provided by the government increases as well and it is rational for the government to operate such type of lottery.

The reasoning behind this is that in an economy without any lottery individuals experience only positive externality from the contributions to the public good. Hence, they do not account for the effect of the higher level of the public good on the whole society into the utility function, they account only for their personal benefit from the consumption of the public good. Therefore they consume smaller amounts of the private good than it would be socially optimal. The concept of the VAT lottery introduces a negative externality. This means that if an individual decides to register more sales receipts for the lottery, the probabilities of winning of all other customers decrease at the same time. Based on Morgan (2000), the negative externality is unable to offset the positive externality. But, the presence of the lottery still alleviates the gap that is between the private and the social benefit. As a result, the total sum of purchases increases and therefore the level of the public good increases at the same time.

So far, the existence of only one prize was assumed. But the real lottery introduces 100 identical prizes for the customers. Formally, assume that every cash prize is equal to R and amount of prizes is equal to m ($m \in \mathbb{N}$). Then it is possible to obtain the following formula, which expresses the expected win of the i^{th} individual in one round:

$$E_i(win) = \sum_{k=0}^{min\{m,a_i\}} \frac{\binom{a_i}{k}\binom{a(N/i)}{m-k}}{\binom{a(N)}{m}} kR.$$

Therefore the utility function of i^{th} individual looks as follows:

$$EU_i = w_i - a_i + \theta_i(a_i) + E_i(win),$$

where

$$\theta_i(a_i) = \Big(\tau a(N) - mR, (1-\tau)a_i\Big)$$

The necessary condition for the level of the public good is that $\tau a(N) - mR \geq 0$.

Differentiating with respect to a_i yields set of first-order conditions

$$\frac{dEU_i}{da_i} = -1 + \theta_i'(a_i) + \frac{dE_i(win)}{da_i} \leq 0.$$

Since the preferences of the individuals are described by quasi-linear utility functions, the results that Morgan (2000) derived for his theoretical model do hold for this multiple-prize VAT lottery as well[2]. Hence, this lottery has a unique equilibrium and provides a higher sum of purchases $a(N)$, compared to the economy with no VAT lottery. Also the level of the public good that is provided is higher, because $G = \tau a(N) - mR$. So this lottery, theoretically, increases the total tax revenue collected by the tax office.

[2]Provided that $a(N/i)k - m > 0$. This assumption is very likely to hold since the total amount of registered sales receipts is much bigger than the amount of prizes introduced. The case when $k = 0$ is not very interesting because in such case the expected win is zero and so even though given the assumption does not hold, the results are not affected by this fact. Under this assumption, $\partial E(win)/\partial a_i > 0$.

3.3.2 Jackpot

The next part of the lottery offers only one prize and the main difference is that this prize is not fixed but its value is made endogenous. The value of the Jackpot is determined in the following way: for every registered sales receipt the lottery administrator puts 1 cent into the prize pool. Additionally, only 70% of the value of the Jackpot is paid off to the winner after all. The rest creates the base prize pool of the Jackpot of the following drawing. That is true in the reality but for the purpose of modelling, suppose that the whole amount of the prize pool of the Jackpot will be paid off to the winner of this part of the lottery. The total prize R is then equal to a proportion of the total amount of lottery tickets. Hence, $R = \alpha a(N)$, where α is a small positive real number. In reality, since the VAT levied on the goods and services in Slovakia is equal to 20%, 1/6 of the total price of the purchase is collected by the tax office and transformed into the public good. Hence, $\alpha = 1/6 * 0.01 = 1/600$ for the first toss up. Consequently, $G = \tau a(N) - \alpha a(N) = (\tau - \alpha)a(N)$. The necessary condition that must be fulfilled in this case is that $(\tau - \alpha) \geq 0$. If the model of the lottery did not satisfy the previous condition, the government would have to pay more on the prizes than it would be able to collect from VAT. It can be seen that this condition holds for the lottery organized by Slovakia. The probability of winning of the i^{th} individual is the same as in the First chance since every lottery ticket has the same probability of being chosen, therefore

$$\pi(a_i, a_{-i}) = \frac{a_i}{a(N)}.$$

Given the givens, the utility function of the i^{th} individual in this case looks as follows:

$$EU_i = w_i - a_i + h_i\Big((\tau - \alpha)a(N), (1-\tau)a_i\Big) + \frac{a_i}{a(N)}\alpha a(N).$$

In this case it is true that

$$\theta_i(a_i) = h_i\Big((\tau - \alpha)a(N), (1-\tau)a_i\Big)$$

Taking the derivative with respect to a_i yields following first-order conditions:

$$\frac{dEU_i}{da_i} = -1 + \theta_i'(a_i) + \alpha \leq 0.$$

It can be seen that these conditions do not depend on the value of the prize but only on the parameter α. Hence, a higher value of the prize R does not affect the additional motivation to make one more purchase. When compared to any other model that has already been analyzed throughout this thesis, the FOC have always depended on the value of the prize so far. This dependence has one important implication. Morgan (2000) claims that with an increasing R the level of the public good increases as well. And if R gets large enough, then the level of the provided public good can be really close to the socially optimal level. That is because the gap between the private and public benefit diminishes as R increases. However, the motivation to make one more purchase can be increased in this case, too. But the parameter that affects it is α. So if α increases (practically, if TIPOS decided to put 2 cents into the prize pool instead of just 1 cent for every sales receipt that was registered), then the motivation to make one more purchase increases as well.

Even though the first-order conditions do not depend on the value of the prize, this part of the VAT lottery has a unique equilibrium under the assumption that preferences are quasi-linear. Since this assumption is not violated, this part of Slovakian lottery also provides higher $a(N)$ and hence, a higher level of the public good can be provided by the government.

3.3.3 TV chance

This part of the Slovakian VAT lottery introduces a different type of prize structure for the consumers. More precisely, they are not able to win money when participating in the TV chance. The prize is the opportunity to attend the filming of a well-known TV contest "The Price Is Right". This game has a following structure: a few people from the audience are determined at random to participate in the contest and their task is to guess the prices of shown items. So they guess prices of different cars, trips around the world, expensive household merchandise as well as prices of small and cheap grocery items. The participant, who guessed the least deviated price from the true value of the item wins the competition and gains either a cash prize or a different prize such as a new car or a trip. The problem is that the participants do not know the prizes beforehand, they just know that a few prizes will be paid off. That was the real model of this part of the lottery and now, the theoretical model of this part will be presented.

Again, suppose that all issued sales receipts do participate in the lottery. In reality, m tickets are determined by a lot as well as another n tickets in case that one individual is chosen two or more times in the first round or if some of the individuals determined by the first drawing are unable to attend the recording in the television studio. The audience of the television studio has to be fully occupied so that is why another n tickets are determined by a lot. But for simplicity assume that only m lottery tickets are chosen and that all individuals are identical. The fact that an individual might be chosen more than 1 time in a given round is ignored. Just suppose that when an individual is determined by a lot, all other lottery tickets of that individual are taken away from the drawing. Then suppose that k ($k \in \mathbb{N}, k \leq m$) individuals are chosen to play the TV game so out of m individuals present in the television studio k actively participate in the game. And the last assumption is that only one individual can win the prize R. Suppose that it is a cash prize, because if it was a non-cash prize, it would have to be accounted for in the total private good possessed by customers. Therefore, the probability of winning for any individuals is equal to

$$\pi(a_i, a_{-i}) = \frac{\binom{n-1}{m-1}}{\binom{n}{m}} \frac{\binom{m-1}{k-1}}{\binom{m}{k}} \frac{1}{k} = \frac{1}{n}.$$

Plugging this into the utility function yields

$$EU_i = w_i - a_i + \theta_i(a_i) + \frac{1}{n}R,$$

where $\theta_i(a_i) = h_i(\tau a(N) - R, (1-\tau)a_i)$. The necessary condition in this case is that $\tau a(N) - R \geq 0$. Taking derivative with respect to a_i yields first-order conditions of the form

$$\frac{dEU_i}{da_i} = -1 + \theta_i'(a_i) \leq 0.$$

These FOC are the same as the FOC in the case that no lottery is present. Hence this part of the VAT lottery does not increase the total amount of purchases $a(N)$ and does not yield higher tax revenues. The amount of the money collected by the tax office in this case is the same as if no lottery exists.

To make the model more realistic, suppose that the individuals are not identical anymore and yet, the fact that an individual can be chosen more than once in one round is ignored. It is not very likely that something like that happens and also this problem is solved in practice by having extra n participants that can come to the recording when such problem appears. The probability of the i^{th} individual of being chosen to participate in the filming of the TV show is equal to

$$\pi(a_i, a_{-i}) = 1 - \frac{\binom{a(N/i)}{m}}{\binom{a(N)}{m}}.$$

The possibility, that an individual is chosen more than once is accounted for in the given formula. Now, suppose that it might happen that one individual occupies more than 1 place in the TV studio, denote m^s ($m^s \in \mathbb{N}$, $m^s \leq m$) the amount of different individuals that do attend the recording in the studio. Assume that all individuals have equal probability to win the game, then suppose that k individuals are chosen to play the game and only one of them can win the cash prize R. Hence, the probability of winning for the i^{th} individual is equal to

$$\pi_i(a_i, a_{-i}) = \left(1 - \frac{\binom{a(N/i)}{m}}{\binom{a(N)}{m}}\right)\frac{1}{m^s}.$$

The adjusted utility functions look as follow:

$$EU_i = w_i - a_i + \theta_i(a_i) + E_i(win)$$

where $\theta_i(a_i) = h_i\big(\tau a(N) - R, (1-\tau)a_i\big)$ and $E_i(win) = \pi_i(a_i, a_{-i})R$. Differentiating with respect to a_i yields first-order conditions of a form

$$\frac{dEU_i}{da_i} = -1 + \theta_i'(a_i) + \frac{dE_i(win)}{da_i} \leq 0.$$

Assuming that the preferences are quasi-linear, then this part of the VAT lottery has a unique equilibrium and provides higher $a(N)$. Therefore the total level of the public good increases, when compared to the case with no VAT lottery.

To sum up this subsection, all parts of the Slovakian lottery can be modelled as charitable lotteries from Morgan (2000). Since all assumptions raised by Morgan (2000) are satisfied, all parts theoretically provide more of the public good and all of them have unique equilibria.

Chapter 4

Discussion

The purpose of this chapter is to critically review the reliability of the assumptions and whether they are likely to be satisfied in the real world. Also a few practical issues that might affect the final effect of the VAT lottery are described and discussed throughout this chapter.

One assumption, that is very unrealistic is that the value of every purchase is equal to exactly 1 unit of the numeraire good. In reality, there exist cheap and expensive items which implies that values of different purchases may differ a lot. Also when going to a grocery store, customers pay for the whole shopping instead of paying for every item separately. However, it is not considered to be an unusual behaviour when customers in Taiwan want to pay for every item separately in order to have as many sales receipts as possible. Since no registration is required (compared to Slovakia), all sales receipts are automatically included in the lottery and capable of winning. Hence, it is very rational to pay for everything separately because customers might increase their probability of winning considerably. And since they would buy these items anyway (when talking about food for example), no extra costs are faced by consumers. There are only time costs when customers want to pay for every item separately. These larger time costs are outweighed by higher expected win. After all, this cannot be considered as an inaccuracy of the model and implications of the theoretical models do hold anyway.

The situation in Slovakia is a little bit more complicated because the model of the lottery is designed differently. First of all, it might not be optimal to pay for every item separately because only sales receipts with face value higher than €1 may be included in the lottery. Also, since every sales receipt must be registered in order to be capable of winning, extra costs are faced by the consumers and the theoretical model does not account for that. Customers have to spend a lot of time when they want to register sales receipts for the lottery. Typing long series of numbers and letters into the text message or text boxes on the web page might be found frustrating and long-lasting. Moreover, when registering receipts in the branch offices of TIPOS or via text message, one has to pay for the registration of every receipt. This means that the opportunity to win the prize increases the motivation to pay taxes, but this increase is partially counteracted by the presence of all these institutional rules. Hence, the lottery should still provide a higher level of the public good but this level would be higher if there were no extra costs. In the most extreme case it might happen that there is no increase in the level of the public good. That might be true if the registration costs are really high.

Another assumption that is very likely to be violated is the one that all issued sales receipts participate in the lottery. The existence of the registration costs decreases the amount of registered sales receipts by all means. When someone decides not to register a sales receipt, it is a positive thing from the point of view of other customers because their probabilities of winning will not be reduced. However, this is not so good from the point of view of the government since one of the main goals of the lottery is to keep track of all purchases in the given country because then the tax office has the opportunity to collect more money on taxes. One solution might be to have the same system as Taiwan so that no registration would be required. Another solution proposed by Taiwan is that consumers might have some kind of a card and information about all transactions can be recorded onto that card. This would also solve another problem. It is always very hard to find whether one of the sales receipts is winning when one has hundreds of small pieces of paper (sales receipts) at home. Even the idea of keeping so many tiny papers is not very tempting at all. Nevertheless, winners in Slovakia receive an e-mail or a text message when they possess a winning ticket, but only if they register their sales receipts on the web page or via text message. If they register their receipts in one of the offices of TIPOS, they have to compare all registration codes to the winning ones manually. The same holds for Taiwan and people without such card, they also have to check all sales receipts manually. It is probably not that hard to imagine that such search might be found frustrating, especially when no lottery ticket is found to be the winning one. After all, there is one positive implication for Taiwan. Since some of the tickets probably do get lost or thrown away or something else, not all prizes due have to be paid off. This implication might be true for Slovakia as well, but in a smaller amount of cases since people not interested in the lottery are sorted out by the mandatory registration of every sales receipt.

In reality, there is also another problem linked to the sales receipts and that is the fact that different sales receipts have different face values. This means that every purchase contributes to the total amount of the public good with a different amount of money. However, the probability of winning is not affected by this. It does not matter whether one buys small chocolate for a few cents or a big new expensive television for a few thousands. Both sales receipts have the same probability of being chosen and win. Therefore customers might be motivated more to register the sales receipt when the chocolate is bought since the prize that can be won is much higher than the value of VAT paid. On the other hand, it might be tempting to cooperate with the seller when a new TV or a car is bought. More about this issue can be found in the next chapter.

Another assumption that is not very realistic is the assumption about risk neutral individuals. When describing real participants in the lottery, not all of them are risk neutral. Some people just love risk and they are always willing to play hazard games, another group of people does not like risk and would never participate in such lottery. The behaviour of the participants of the lottery therefore depends on the attitude towards risk. Risk-loving individuals are more eager to play the game and more likely to register greater amount of sales receipts than risk-averse individuals. Risk-loving individuals are also willing to participate in the lottery even though a very small prize is offered. A much greater prize would have to be offered to convince risk-averse individuals to participate in the lottery. So the higher the prize, the more individuals want to play the lottery. These attitudes also influence the motivation to cheat, as it will be discussed in the following chapter.

One issue that only Taiwan faces is the fact that the amounts of prizes that have to be paid off are not predetermined in advance. The government is therefore unable to calculate the expenses on the lottery precisely. It might be the case that there are more consumers with identical number on their sales receipts and then all these sales receipts match the winning number. That implies higher costs on the side of the government. It is plausible that the total increase in the tax revenues will be lower than the amount of money paid off in the form of winnings in one round. On the other hand, there might be rounds in which no one wins one type (or more types) of prize. Also, as stated before, not all prizes due will be paid off because a few tickets might get lost or thrown away so this should balance the lottery budget as well. So in general, if all necessary assumptions are fulfilled, then the presence of the lottery does imply increased levels of the public good, even though it might not be true for some of the rounds. However, consumers have to account for the fact that if they collect arbitrary large amounts of sales receipts, then the government might be forced to pay way greater amounts of money on prizes than it collects on the VAT. So in a very extreme case it might be counter-productive to obtain one more sales receipt. In such case customers have to expect a very low level of the public good and account for that.

One argument linked to the model of the second part of the Slovakian lottery can be raised. The model analyzes only the very first drawing for the Jackpot. It might be also interesting to see how the decision making process of the lottery participants changes when time dimension is introduced to the model. In such case the decision about the purchase made in one period affects all the other time periods after that, since every time only 70% of the prize pool is paid off and the rest is used as the base prize pool of the next drawing. It would be much harder to model the total prize pool after a few rounds. So to keep the modelling simple, only the first drawing was taken into account, even though it is not completely accurate.

The TV chance of the Slovakian lottery is very interesting because it is not a type of classical lottery. Even though the probability of being chosen to play the game depends only on the randomness, the probability whether the chosen individual wins the game does depend on one's personal features. For example, a person that does not have stage fright is more likely to win because such person will think faster and clearer. Also, people who shop a lot (or watch the game regularly) and know the price ranges of different items have an advantage surely. Therefore the assumption that all individuals are equally likely to win is not true at all in real life. But this assumption simplifies the calculations to a large extent so that is the reason why it has been used while modelling.

When looking at the lottery as a whole, a few final remarks come to mind. The theoretical analysis showed that both lotteries should provide more of the public good. But one very interesting question is: Which part of the lottery motivates participants the most? With no hard data it is very hard to answer such question. The only direct implication is that these lotteries should increase the total tax revenue. Another question is whether the lotteries are not too recompiled. Maybe it is possible to provide the same level of the public good with smaller amount of prizes or with smaller amount of money paid off in total. Even though it is possible to conclude that both lotteries should theoretically increase the level of the public good, it is not analyzed whether the introduced models of the lotteries are the best possible models that could have been proposed.

And last but not least, the most severe issue is that so far nothing has been said about the third subject that plays very important role in the economy. The assumption that all of the money goes directly into the national budget is not even close to the reality in this case. There exists a middle subject between consumers and the government and that is firms. Since the presence of the firms demands deeper analysis, the next chapter presents and discusses the whole concept of the sales tax lottery in the case that also the existence of firms is taken into account.

Chapter 5

What role does the firm play?

Even though the results of the theoretical model are very promising, these results are based on the premise that only two sectors actively participate in the economy. In other words, only the consumers and the government are present and they communicate directly with each other. However, the impact of firms cannot be ignored in reality. Firms serve as the intermediaries in the whole process of tax collection, they collect value-added tax from consumers in order to pay it to the tax office later.

5.1 Environment

So suppose an economy like before but now also set of l profit maximizing firms is present, where $l \in \mathbb{N}$. The well known profit function for a firm has a form

$$\Pi_j = TR_j - TC_j;\ j \in \{1, 2, ..., l\}.$$

Π_j denotes the profit of the j^{th} firm in the economy, TR_j stands for the total revenue of this firm and TC_j denotes the total costs of this firm. All these firms sell private good to the customers and have to pay taxes from every unit that is sold. Assume that every firm sells b_j units of the private good ($\forall j \in \{1, 2, ..., l\} : b_j \in \mathbb{N}$). Moreover, suppose that the post-tax price of the private good is equal to 1 and firms are assumed to be price-takers in this model. Hence, assume that consumers make the final decision where they want to make a purchase and firms cannot change their decision. So b_j is constant from the point of view of firms. Furthermore, assume that the firms face constant costs for selling one unit of the private good equal to c ($c \in \mathbb{R}_+$). Finally, this yields the profit function of the form

$$\Pi_j = b_j(1 - c).$$

The necessary condition that must be satisfied is $(1 - c) \geq 0$, otherwise the firm makes a loss on every purchase and such firm is unprofitable in the long run.

5.2 Cheating

As it was stated before, customers purchase the private good from firms and not from the government. Hence, firms interact with the customers directly while the government interacts with the customers indirectly. Given the system, this introduces an opportunity for a firm to cheat and pay a smaller amount of taxes due, because the profit of the firm can be increased considerably. Consequently, the level of the public good decreases since tax revenues are smaller. However, if consumers collude with firms, the economic well-being of the customers might increase as well, even though the utility of the consumers partially decreases because smaller level of the public good is provided. But firms have to compensate for this loss. Nevertheless, firms have more opportunities to cheat while customers can cheat only in cooperation with firms.

5.2.1 Evasion of VAT by firms

Basically, there are two possible ways how a firm can cheat. In the first scenario the firm acts on its own and cheats independently. This means that the firm collects taxes from the consumers but does not pay them to the tax office. Some firms may pay part of the taxes due, some may not pay anything to the government, it depends on the preferences and on the attitude of the firm towards risk. Nevertheless, the level of the public good that is provided by the government is smaller than it would have been if firms paid the whole amount of taxes due. Therefore all citizens experience lower utility levels at the same time, since $\partial U_i(.)/\partial G > 0$.

Suppose that there exists a firm in the economic system that decides to keep the whole tax revenue for itself. Hence, the profit of such firm increases by $b_j\tau$. However, such firm faces the probability of being caught in the act that can be denoted as p_j. If caught, such firm has to face the punishment. It might be only a fine in less severe cases. In more severe cases, some of the managers (eventually workers) might end up in jail, that happens if the amount of taxes that should have been paid to the government is higher than a certain treshold defined by the law. Moreover, the reputation of the firm would be inevitably damaged and that would affect the profit of the firm by all means. But for simplicity suppose that the firm would have to pay the fine that is equal to F ($F \in \mathbb{R}_+$). Hence, the expected profit of the j^{th} firm changes and the adjusted profit function now has the form

$$\Pi_j = b_j(1-c) + b_j\tau - p_jF.$$

The expected profit of the cheating firm can be compared to the profit in the case when the firm pays the whole amount of taxes to the tax office. Hence, the total change in the profit is equal to

$$\Delta\Pi_j = b_j\tau - p_jF.$$

If $\Delta\Pi_j > 0$, then it is more profitable for the firm to cheat, even though it faces the risk of being caught. However, if $\Delta\Pi_j = 0$, then the firm is indifferent between cheating and fair game since they both yield the same profit.

Now, suppose that some firms want to keep only a fraction of the collected VAT. Since the fine and the probability of being caught are being fixed, there exists a lower bound on the amount of money that has to be kept by the firm so that the expected profit is higher than in the case when the firm plays fair game. So in general, the necessary condition that must be satisfied is that

$$T_j \geq p_jF,$$

where T_j ($T_j \in \mathbb{R}_+;\ T_j \leq b_j\tau$) is the amount of money the firm decides to keep instead of paying it to the tax office. If the necessary condition holds, then it is profitable for the firm to cheat. However, if $b_j\tau \geq p_jF$, then it is rational for the profit maximizing firm to keep the whole amount of taxes that should be paid to the tax office.

In reality both the probability of being caught p_j and the fine F often depend on the amount of money that is not paid to the tax office. So the model can be more accurate, just assume that the higher the amount of money that is not paid to the tax office, the higher the probability of being caught. The same can be assumed for the fine, the fine defined by the law increases with the increasing amount of money that should have been paid to the government. Formally,

$$\frac{dp_j(T_j)}{dT_j} > 0 \quad and \quad \frac{dF(T_j)}{dT_j} > 0.$$

The form of the profit function changes a little, therefore

$$\Pi_j(T_j) = b_j(1-c) + T_j - p_j(T_j)F(T_j).$$

Again, the profit of the firm when cheating must be higher than when playing fair game and paying the whole amount of taxes due to the tax office. The necessary condition that must be fulfilled in this case looks as follows

$$T_j \geq p_j(T_j)F(T_j).$$

Since the profit function is assumed to be a continuous function defined on the compact set, this function has its maximum on this interval. Hence, there exists an optimal amount of T_j^* $\left(T_j^* \in \left[0; b_j\tau\right]\right)$ that yields the highest possible profit for the firm. However, if $\Pi_j(T_j^*) < \Pi_j(0)$, then it is optimal not to cheat. If $\Pi_j(T_j^*) = \Pi_j(0)$, then the firm is indifferent between paying the whole amount of taxes due and cheating, because both yield the same profit in the end. Practically, the safest option is to pay the tax to the tax office in this case.

The lottery itself does not solve this problem of cheating directly but it tries to motivate firms to pay the whole amount of taxes indirectly. When consumers do not care about the sales receipts and do not demand them, they automatically create an opportunity for firms to cheat, since such transactions might end up unrecorded in the book of accounts. Adjective unrecorded in this case basically implies that such purchases have not been officially made since there are no official information about them. The tax office is therefore unable to demand taxes from these purchases. The lottery wants to motivate the customers to ask for the sales receipts after all purchases that are made. This demand for sales receipts creates a bigger pressure on sellers to record more transactions since the probability of being caught when cheating is higher when the lottery exists. This higher risk is induced by more frequent controls of the books of accounts or by the fact that all winning sales receipts are checked whether they have been issued by a valid cash register and whether there are entries in the books of accounts of given shops about these purchases. In Slovakia there exists an extra verification system that controls whether the cash register that has issued the sales receipt that the customer wants to register for the lottery is registered by the tax office or not. When an unregistered cash register is found, the consumer has the opportunity to inform the Financial Administration of the Slovak Republic and the shop that possesses the given problematic cash register will be controlled by this institution. The first results show that controls are more efficient in finding businesses that try to increase their profits illegally. The Slovakian IFP claims that the existence of the lottery probably also helped to increase the efficiency of controls because much more problematic sales receipts are reported to the Financial Administration. So the first data shows that the lottery may have positive effects and that more unfair playing firms are caught in the act due to the better control mechanisms and higher interest of the customers.

5.2.2 Collusion among firms and consumers

Unfortunately, firms are partially able to overcome higher chance of being caught. This can be achieved if a firm decides to cooperate with its customers. When cooperating, the fact that also consumers act against the law and might be punished partially offsets the higher probability of being caught in the act when a lottery is present. So after all, such cheating might be profitable, since collusion partially decreases the probability of being caught and increases the profit at the same time. But part of the increased profit has to be paid to the consumers as the compensation because if they cooperate in the collusion, they loose the opportunity to participate in the lottery and eventually win prizes.

In this case, the profit function of the j^{th} firm has a form

$$\Pi_j = b_j(1-c) + T_j - C_j - p_j^c F^c,$$

where T_j is the amount of collected taxes that is not paid to the tax office. Hence, the tax office obtains only $b_j\tau - T_j$ from the j^{th} firm. C_j denotes the amount of money that is paid to the customers as the compensation for their participation in the collusion, so $C_j \in \mathbb{R}_+$. p_j^c denotes the probability of being caught when the firm cooperates with the customers. Also, $p_j^c < p_j$ where p_j denotes the probability of being caught when the firm cheats on its own. F^c denotes the fine that the caught firm has to pay in this case. At first assume that the probability of being caught in the act and the fine do not depend on the value of T_j. The necessary condition for cheating that must be fulfilled in this case is

$$\Delta\Pi_j = T_j - C_j - p_j^c F^c \geq 0,$$

otherwise it would not be profitable for the firm to cheat. If $\Delta\Pi_j = 0$, the firm is indifferent between collusion and fair game. Again, there exists a corner solution, hence, a lower bound for the amount of money that must be kept by the firm so that the profit increases even though the fine is introduced. If $b_j\tau \geq C_j + p_j^c F_j$ and the firm wants to maximize its own profit, then it is rational to pay nothing to the tax office.

Now, assume that the probability of being caught and the fine do depend on the amount of money that is not paid to the government and that both increase with the increasing level of T_j. Therefore, the profit function of the firm may be rewritten as

$$\Pi_j(T_j) = b_j(1-c) + T_j - C_j - p_j^c(T_j)F^c(T_j).$$

Hence, the necessary condition that must be fulfilled is that

$$T_j \geq C_j + p_j^c(T_j)F^c(T_j).$$

Since the profit function is again a continuous function defined on the compact set, it has its maximum on the given interval at the point T_j^* $\left(T_j^* \in \left[0; b_j\tau\right]\right)$. If $\Pi_j(T_j^*) < \Pi(0)$, then it is optimal not to cheat because the firm would never be better off than when playing fair game. If $\Pi_j(T_j^*) = \Pi_j(0)$, then the firm is indifferent between cheating and playing fair game. But again, practically, the safest option would be to pay the whole amount of tax to the tax office. And there is one more problem, even though that some level of C_j is offered for redistribution among consumers, they might reject it if the value is not large enough. In such case at least the necessary condition must be still satisfied for any level of C_j that differs from the optimal value, otherwise it is not profitable to offer collusion to customers.

That was an analysis from the point of view of firms. But now also the point of view of consumers must be analyzed. So firstly suppose that none of the customers cheat. The utility function in that case looks as follows:

$$EU_i = w_i - a_i + h_i(\tau a(N), (1 - \tau)a_i) + E_i(win).$$

The form of the utility function of the consumers that cheat changes as well. Suppose that the amount of purchases made does not change in this case so that consumers do not change their consumption while cheating. First of all, the level of the public good decreases since the tax office collects a smaller amount of money that can be transformed into the public good. So assuming that G^c denotes this amount of public good, then $G^c < \tau a(N)$. Second of all, the customers that participate in the collusion cannot win any prizes in the lottery or eventually, the probability of winning is smaller since they do not ask for the sales receipt every time they make a purchase. Hence, the expected win from the lottery is smaller, $E_i^c(win) < E_i(win)$. Third of all, firms have to compensate for this lower expected win therefore a lower price of the purchase or eventually some presents might be offered to the customers. Denote this compensation as C_i ($C_i \in \mathbb{R}_+$). And finally, the customers that cheat face the risk of being caught as well, denote this probability of being caught as p_i^c. And assume that when caught, they have to pay a fine, that is equal to F^c. So the utility function looks as follows:

$$EU_i = w_i - a_i + h_i(G^c, (1 - \tau)a_i) + E^c(win) + C_i - p_i^c F^c.$$

If there is an increase in the expected utility, then it is profitable for the consumer to cheat, since these consumers are assumed to be risk-neutral utility maximizers. Theoretically,

$$\Delta EU_i = \Delta h_i(.) + \Delta E_i(win) + C_i - p_i^c F^c,$$

where $\Delta h_i(.) = h_i(G^c, (1 - \tau)a_i) - h_i(\tau a(N), (1 - \tau)a_i)$ and $\Delta E_i(win) = E_i^c(win) - E_i(win)$. If $\Delta EU_i > 0$, then it is more profitable for a customer to cheat because a higher level of utility can be achieved. A special case is if $EU_i = 0$, then the customer is indifferent between collusion and fair game since they both yield the same level of utility, after all. In other words, the level of compensation must be high enough to convince the customers to cooperate in the collusion. There exists a lower bound for the amount that convinces the customer to cheat. Formally,

$$C_i \geq p_i^c F^c - \Delta h_i(.) - \Delta E_i(win).$$

The upper level of the value of the compensation depends only on firms and how much they are willing to offer while still making a greater profit than before. But for the utility maximizing consumer it is rational to accept the highest possible compensation that is offered, assuming that the previous condition is fulfilled.

This case might also account for the fact that the probability of being caught and the fine depend on the amount of money that is not paid to the government. So suppose that the total fine and the total probability of being caught are positively correlated with the level of the compensation that is accepted by the consumer. It is rational to use this proxy variable since the level of the compensation is in fact part of the tax revenues that is being kept by firms in the model. So assume that

$$\frac{dp_i^c(C_i)}{dC_i} > 0 \quad and \quad \frac{dF^c(C_i)}{dC_i} > 0.$$

Then the form of the utility function changes and it looks as follows

$$EU_i(C_i) = w_i - a_i + h_i(G^c, (1-\tau)a_i) + E_i^c(win) + C_i - p_i^c(C_i)F^c(C_i).$$

Again, the necessary condition that must be satisfied is

$$C_i \geq p_i^c(C_i)F^c(C_i) - \Delta h_i(.) - \Delta E_i(win).$$

Assume that the highest possible value of the compensation is equal to τa_i. This is a very extreme case because if the compensation was really equal to that value, none of the firms would really increase their profit while cooperating with the ith individual. These firms would just risk a lot and pay the whole amount of VAT back to the consumer. But that is the highest possible theoretical value and it might be used because then the utility function is continuous on the compact set where $C_i \in [0; \tau a_i]$ and it has its maximum on that interval that is reached at point C_i^*. If $EU_i(C_i^*) < EU_i(0)$ then it is more rational to pay the VAT to the seller. And if $EU_i(C_i^*) = EU_i(0)$, then the consumer is indifferent between collusion and fair game. However, the optimal amount C_i^*

might not be offered to the customer, it might be a value that is very irrational to offer, from the point of view of firms at least. Then the necessary condition must be satisfied for the value of the compensation C_i that is really offered.

Practically, the expected win in the lottery is not that large. Based on the empirical evidence, it is very hard to compute the value of the expected win for the lottery in Slovakia because the last official amount of registered tickets is known for the April 2014 and the model of the lottery was changed in September 2014. But it is at least possible to compute the expected win of the lottery in Taiwan. The expected win from having one sales receipt in Taiwan is equal to approximately NT$2. Just to illustrate how large the expected win is, the average price of a 1 liter of milk is around NT$82, the average price of a loaf of bread is approximately NT$44 and 1 kilogram of rice costs NT$70 on average[1]. The VAT levied on goods and services is equal to 5% or to 0%. From this short comparison it can be seen that the expected win from having one sales receipt is really small and a regular consumer is not able to buy anything for that amount of money. And still it is only the expected win so it is also very likely that a consumer does not win anything in the lottery. However, when comparing the expected win and the tax that is paid for a purchase of a milk or a bag of rice, these values are almost equal. Naturally this is not true for all purchases, just imagine that a new car or a new house are being bought, then the tax that has to be paid is much higher than the expected win. In such case the firm can also offer a greater compensation while still increasing its profit considerably. That is something that the model on the aggregate level is unable to account for since the value of the purchase is held fixed.

5.3 Further issues

At this point the nature of the consumer must also be taken into account. Consumers that are risk-averse can be more likely to demand sales receipts and even inform the tax office about the fact when a possibility of cheating is offered to them. However, since such individuals do not like risk that much, it is also less likely that these individuals participate in the state-run lottery. But there is nothing they can lose when playing the lottery so the design of the lottery might suit such individuals very well. On the other hand, there are

[1] Using data for average prices from April 2015, for more information see f.e. http://www.numbeo.com/cost-of-living/

many consumers that love risk and are willing to participate in the collusion. But they are also more likely to play the lottery. The risk linked to cheating is definitely higher than the risk linked to the lottery, so from this point of view they might consider cheating to be an more exciting option. And as the comparison in the paragraph before showed, cheating may result in having more money for sure than playing the lottery with an unsure win.

These natures also influence the size of the compensation that is sufficient to convince the given consumer to participate in the collusion. Risk-averse individuals would definitely demand a higher compensation than risk-loving individuals. It is hard to say how big amount of money is sufficient to convince risk-averse or risk-loving customers to participate in the cheating, it depends on their preferences. The value of the smallest possible compensation is unique for all individuals in the model. But it is possible to claim that the lowest compensation for the risk-loving individuals that convinces them to participate in the collusion is lower than for risk-neutral individuals and that the lowest compensation for risk-averse individuals is higher than for the risk-neutral individuals.

However, different natures of consumers introduce a problem called asymmetric information. The problem is that only consumers know whether they are risk-loving or risk-averse but firms do not have information about that in advance. Hence, firms face another risk. They might offer a cooperation to a very risk-averse customer and their risk of being caught in the act increases considerably. The consumer might also offer a collaboration to a firm, but that is a positive sign for a firm that really wants to cheat. However, there definitely exist firms that would reject such an offer. Basically there exist two different types of cooperation. If a firm offers a compensation for collaboration to a customer, then it is said to be a screening model, because the participant with a smaller amount of information offers the collaboration. On the other hand, if a customer asks for a compensation from a seller, then it is said to be a signalling model since the participant with a greater amount of information offers the collaboration. The signalling model is way more profitable when compared to the screening model. In the first case firms simply choose customers at random and offer them compensation for cheating so some offers may end up very badly if offered to improper individuals. Hence the risk might vary a lot. Also it is natural to assume that when a firm offers cheating, then a higher level of compensation is necessary to convince customers to cooperate. Basically, this system is very inefficient when compared to the signalling model. Then firms may address only customers that are interested in cheating and the risk may be kept on a very low level when compared to the screening model. Naturally, the required level of compensation is probably smaller since these individuals are willing to cheat anyway. So the risk of being caught and the level of the compensation also depend on the fact whether a firm or a customer offers a cooperation.

The motivation to cheat also depends on the preferences towards the public good. When cheating, the personal well-being of consumers increases, otherwise they would not participate in the collusion. So the model accounts for this decrease in the level of the public good and for the personal preferences that some individuals are more altruistic and value the public good more and some are more selfish and value just the private good and money more. Firms that cheat have higher profits that can be reinvested or paid to the managers or something else. However, they also face the decrease in the level of the public good, even though the model does not account for that. Smaller tax revenues imply for example lower quality of schools hence undereducated labour force or smaller amount of roads that can be used for transportation of goods. Eventually lower quality of health care so if workers are ill, it might take them longer time to convalesce. Those are only a few examples of consequences that might follow if the level of the tax revenues drops abruptly. Also factors as education or the quality of roads might limit the future development of firms in a given country to a great extent. Hence, there are some hidden costs for cheating firms and they have to account for higher transportation costs, workers benefits costs or training costs as well. It is likely that even if a firm accounts for all these factors, it is more profitable to cheat. Anyway, the willingness to cheat depends also on the preferences of firms towards the level of the public good, even though the model does not account for that.

One of the important factors is how the society perceives cheating. Citizens of some countries might take it very personally and are highly offended when they discover that other citizens or firms cheat. In other countries it might be considered normal and no one really cares too much. Cheating firms in the first type of countries might lose much more compared to the firms that cheat in the other type of countries or societies. Hence, this common attitude towards cheating and moral norms that hold in different countries might also affect the attitude towards cheating.

Another small limitation of the model is the assumption that firms are basically price takers, since the price of the private good is predefined in the previous chapter. As it has been already discussed, this is not usually the case in reality and values of the purchases vary a lot. And also exact prices of different goods and services are determined on the free market by a matching supply and demand. Hence, firms can to a great extent affect the prices on the market as well. But this limitation is ignored in the process of modelling because the main purpose of the model was to explain whether the presence of lotteries changes the behaviour of the participants and the problem of price modelling is a superior concept to that. It does not affect the main implications in the end.

After all, it is very hard to exactly quantify whether it is more profitable for firms or consumers to cheat and participate in the collusion or not. There are many factors that shape the final decision, for example preferences towards public good, private good, risk. When assuming only risk-neutral consumers that are non-altruistic, it might be rational for them to cheat. Also from the point of view of profit maximizing firms it might be more profitable for them to cheat. They must also carefully evaluate which form of cheating yields higher profit under certain circumstances. Sometimes it might be better to cheat alone, sometimes it might be more profitable to cooperate with customers. Nevertheless, cheating implies that smaller amount of money is collected by the tax office. Hence, a lower amount of the public good that would be socially optimal is supplied. And also, if only a few individuals cheat and are better off, then there must exist individuals that are worse off. So it would be interesting to see whether the total social welfare increases or decreases if only a few of the firms or customers cheat.

Chapter 6

Conclusion

To summarize the thesis, the main task was to find out whether the VAT lotteries used in Taiwan and Slovakia can be modelled using a similar approach as Morgan (2000) used in his paper where he analyzed charitable lotteries. Many limitations of the models have been discussed throughout the thesis, mostly in Chapter 4 or Chapter 5. In particular, Chapter 5 mainly analyzed the problem of tax evasion and described the motivation of firms or consumers to participate in cheating. So after all, only a few of the limitations have significant effect on the possibility to model VAT lotteries as charitable lotteries.

First of all, it was shown that the Taiwanese and Slovakian lotteries can be analyzed in a similar way as Morgan (2000) analyzed charitable lotteries and that it is reasonable to model the VAT lottery as a charitable lottery. The general conclusion is that in an economy that consists of risk neutral utility maximizing individuals with quasi-linear preferences, the presence of the Taiwanese or Slovakian lotteries yields more of the public good than economy with no such lottery. Another important implication is that the presence of the lottery creates a unique equilibrium for the economy. The increase in the level of the public good mostly depends on the size of prize, because the bigger the prize, the smaller the gap between the private and social benefit. Hence, the level of the public good can be very close to the socially optimal level if the prize is large enough. However, one very important limitation is that this model does not account for the presence of firms.

Secondly, it has been proved that in an economy as before where a set of profit maximizing firms is present, cheating or collaborating might be found as a more profitable and also more rational option under some circumstances. There are two main factors that influence the willingness to play unfair game, the fine and the risk of being caught. Since the government can affect both variables, it is mostly in their hands whether they create an environment inappropriate for cheating.

Empirically, there are countries as Slovakia, Taiwan or China that can prove that their concepts of the VAT lottery at least partially contributed to the increase in tax revenue. Control mechanisms of different countries are also more efficient in finding agents that do not play fair game and do not pay the whole amount of the VAT to the government when the lottery is present. On the other hand, there is for example Georgia and their failed attempt of the VAT lottery. Hence, in general it may not be claimed that any VAT lottery yields higher tax revenue. The results depend highly on the precise model of the lottery. For future reference, it might be interesting to find the most optimal model of the VAT lottery with the best costs-to-benefits ratio for a given country. Another interesting research problem is to compare the model of the VAT lottery to other state-run lotteries in order to find out which models are more efficient in increasing the total national budget. And finally, since many countries have introduced the lottery only a few years ago, a greater amount of data that can be analyzed will be obtained in a matter of time. Since many other countries as for example Czech Republic or Greece currently wait for the results from Slovakia or Portugal, this concept may become of an even greater importance in a few years time.

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