Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Economics

Bachelor Thesis

Economic Comparison of Bottled vs. Tap Water

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

BACHELOR THESIS ASSIGNMENT

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Economics and Management

Thesis title

Economic Comparison of Bottled vs. Tap Water

Objectives of thesis

The purpose of this bachelor thesis is to assess and compare production of bottled and tap water from the economic point of view. In addition, this thesis will also identify and evaluate the most important factors influencing the final price of bottled and tap water.

Methodology

With reference to scientific literature and data collected from various statistical services, this work will provide a comprehensible overview of the most important components influencing the production of bottled and tap water.

Furthermore, using descriptive statistics methodology and linear regression procedures, this thesis will determine and correlate the top factors influencing the final price of both bottled and tap water.

The proposed extent of the thesis

35+

Keywords

bottled water, tap water, water trade, economic comparison

Recommended information sources

Bergstrom, J., Boyle, K. and Poe, G. (2001). The economic value of water quality. Cheltenham, UK: Edward Elgar.

Feldman, D. (2012). Water. Cambridge, UK: Polity.

Friberg, R. and Ganslandt, M. (2003). Bottled water: a case of pointless trade?. London: Centre for Economic Policy Research.

Gleick, P. (2010). Bottled and sold. Washington, DC: Island Press.

Young, R. (2005). Determining the economic value of water. Washington, DC: Resources for the Future.

Expected date of thesis defence

2016/17 SS – FEM

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Declaration

I declare that I have worked on my bachelor thesis titled "Economic Comparison of Bottled vs. Tap Water" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the bachelor thesis, I declare that the thesis does not break copyrights of any other person.

In Prague on March 15th, 2017 _____

Tereza Zouharová

Acknowledgement

I would like to thank Ing. Petr Procházka, Ph.D., MSc for his professional mentoring throughout the whole time of working on this thesis. I would also like to thank my family and friends who supported me during my studies. And last but not least, I would like to thank all the respondents who were willing to answer my survey.

Economic Comparison of Bottled vs. Tap Water

Abstract

The aim of this bachelor thesis is to look into the basics of water management and compare the productions of bottled and tap water from an economic point of view.

The theoretical part concentrates on the fundamentals of water sourcing and water distribution. The first section also briefly explains the principles of water pricing in the Czech Republic and then examines recent trends in water consumption.

The second part of the theory focuses specifically on tap and bottled water, the differences in their production and distribution, and the different types of bottled water available today.

The practical part of the thesis is in two parts. The first is an evaluation of a survey research on customers' preferences in bottled water consumption and expenditures. And the second is a statistical analysis of the differences in pricing of tap water in restaurants in the Czech Republic.

Keywords: bottled water, tap water, water trade, water supply, economic comparison

Ekonomické porovnání balené a kohoutkové vody

Abstrakt

Cílem této bakalářské práce je prozkoumat základy vodního hospodářství a porovnat produkci balené a kohoutkové vody z ekonomického pohledu.

Teoretická část se zaměřuje na podstatu vodních zdrojů a distribuce vody. První úsek také stručně vysvětluje principy oceňování vody v České Republice a poté se zabývá současnými trendy v konzumaci vody.

Druhá část teorie se soustřeďuje specificky na kohoutkovou a balenou vodu, rozdíly v jejich produkci a distribuci, a různé typy balených vod, které jsou dnes na trhu k dostání.

Praktická složka této bakalářské práce je rozdělena na dvě hlavní části. Tou první je evaluace dotazníkového šetření ke zjištění preferencí zákazníků při konzumaci balené vody a výdajích s tím spojených. A tou druhou je statistická analýza rozdílů v cenách kohoutkové vody v restauracích v České Republice.

Klíčová slova: balená voda, kohoutková voda, obchod s vodou, vodní zdroje, ekonomické porovnání

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1 Introduction

Water is, along with oxygen, one of the fundamental prerequisites for the existence of life on Earth. Humankind cannot survive without it and as such it is the most precious of commodities. Water itself is abundant on Earth, but the amount of it that can be directly used by humans is much more scarce. The quantity of drinkable water is limited and yet the demand for it increases drastically every year. There is a global need for a more ecological and economically expedient approach to water management.

The topic of water trade and water conservation is a continuously debated one, both globally and in the Czech Republic. It is a constantly current topic in a number of different spheres of our society, from scientists, educators and ecologists to governors and private business. This bachelor thesis focuses primarily on the economic aspect of water management.

The thesis is divided into two main parts, the theoretical and the practical. The theoretical part includes all the fundamental terminology connected with water management. The following chapters focus on the water resources available to us and their governance, water pricing, and the progression of water consumption. The last part concentrates specifically on tap water management and bottled water commerce.

The first section of the practical part is aimed at costumers and evaluating their preferences in bottled water consumption. It includes an assessment of an electronic survey and a computation and interpretation of a multiple linear regression analysis.

The final chapter of the practical part consists of a statistical analysis of tap water prices in restaurants in the Czech Republic. I had personally collected the data from one hundred restaurants and analysed whether the final price was influenced by two selected parameters.

2 Objectives and Methodology

2.1 Objectives

The purpose of this bachelor thesis is to assess and compare production of bottled and tap water from the economic point of view. In addition, this paper will also identify and evaluate the most important factors influencing the final price of bottled and tap water.

2.2 Methodology

With reference to scientific literature and data collected from various statistical services, this work will provide a comprehensible overview of the most important factors influencing the production of bottled and tap water. Furthermore, using descriptive statistics methodology and linear regression procedures, this thesis will determine and correlate the factors influencing the final price of both bottled and tap water.

3 Literature Review

3.1 Water management

The following chapter deals with the fundamentals of water sourcing, management, and services. Furthermore, it briefly describes the principles of pricing water and recent trends in water consumption.

3.1.1 Terminology

This chapter explains in short all the basic terminology connected to water management issues, which is used in this thesis.

Drinking water is water that is suitable for consumption with no risk of health problems. In the Czech Republic its quality has to fulfil the Ministry of Health law n. 258/2000 Sb. Drinking water can be used for food preparation but also personal hygiene and other direct contact with a human body.[1]

Rainwater is water from the atmosphere that has not yet touched land or any structures located on it. After touching the ground it becomes surface water.[2]

Surface water is any water on the surface of our planet, both saline and fresh. In its liquid state it can be found in the form of rivers, lakes, seas and so on.[3]

Groundwater is water underground that is in liquid form. It frequently mixes with and influences the surface water due to its existence in the saturation zone.[4]

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[1] 258/2000 Sb. - Zákon o ochraně veřejného zdraví a o změně některých souvisejících zákonů, 2000. *Portál veřejné správy* [online],

[2] Srážkové vody a zákon o vodovodech a kanalizacích, 2006. *TZB-info* [online],

[3] What is Surface Water?, 2001. *Imnh.isu.edu* [online],

[4] What is Surface Water?, 2001. *Imnh.isu.edu* [online],

Water tariff is the price paid for water from the public water supply to its customers. It includes the price of production and distribution of drinking water.[5]

Wastewater tariff is the price paid for the collection and treatment of wastewater from the customers of the water supplier.[6]

Water recycling is the process of chemical and mechanical filtration of water, which is done at the wastewater treatment plant. The reclaimed water can then be used again for flushing toilets, gardening and for various industrial uses.[7]

Water supply system is the aggregate of all the water reservoirs, waterworks, pumps, treatment plants, piping, and other objects that supply the population with water.[8]

Supply lines transfer the water from water sources and water works into the system. They are not directly connected to consumers. ČSN 73 6005 defines them as a distant conduit of the 1st category.[9]

Water-service pipe is the piping segment between the branching-off of the supply lines and the customers' water meter. ČSN 73 6005 defines it as a local conduit of the 4th category.[10]

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[5] Vodné a stočné, 2017. *Vodarna.cz* [online],

[6] Vodné a stočné, 2017. *Vodarna.cz* [online],

[7] Water Recycling and Reuse, 2016. *Www3.epa.gov* [online],

[8] STANDARDY VODÁRENSKÝCH ZAŘÍZENÍ, 2006. *Vodovody a kanalizace Havlíčkův Brod* [online],

[9] STANDARDY VODÁRENSKÝCH ZAŘÍZENÍ, 2006. *Vodovody a kanalizace Havlíčkův Brod* [online],

[10] STANDARDY VODÁRENSKÝCH ZAŘÍZENÍ, 2006. *Vodovody a kanalizace Havlíčkův Brod* [online],

3.1.2 Water resources

Table 1 - Distribution of water sources

Water source	Water volume, in cubic kilometres	% of freshwater	% of total water
Oceans, Seas, & Bays	1,338,000,000	--	96.5
Ice caps, Glaciers, & Permanent Snow	24,064,000	68.7	1.74
Ground water	23,400,000	--	1.69
-Fresh	10,530,000	30.1	0.76
-Saline	12,870,000	--	0.93
Soil Moisture	16,500	0.05	0.001
Ground Ice & Permafrost	300,000	0.86	0.022
Lakes	176,400	--	0.013
-Fresh	91,000	0.26	0.007
-Saline	85,400	--	0.006
Atmosphere	12,900	0.04	0.001
Swamp Water	11,470	0.03	0.0008
Rivers	2,120	0.006	0.0002
Biological Water	1,120	0.003	0.0001

Source: adapted from Gleick, Peter H, Water in crisis (1993)

Around 71% of the Earth's surface is covered with water in the form of oceans and seas. Only about 3% of the world's hydrosphere is made up of freshwater, mostly in the solid form of glaciers, ice caps, and permanent snow.[11] Table 1 shows the estimated distribution of water sources on Earth and their freshwater content.

Because the Earth is a closed system, water is a limited resource. The planet naturally recycles the water supply through the hydrologic cycle, also known as the water cycle. But while both surface and groundwater can be of use to humankind, only about 0.3% of the total volume of water on our planet is available. The remaining 99.7% is in the soil, oceans, icecaps, or dispersed in the atmosphere. Thus most of the water used by humans comes from rivers and other watercourses.[12]

Around 93,4% of the watercourses in the Czech Republic are under the administration of the Ministry of Agriculture. The remaining 6,6% is controlled by other subjects, including the Ministry of Defence, the administration of National Parks, and other natural and legal subjects.[13]

Watercourses in the Czech Republic are categorized as major watercourses, in total length of 16 326 km, and minor watercourses, in total length of 86 553 km. All the major watercourses and about a half of the minor ones are managed by the state enterprises Povodí – Basin. This includes Povodí Vltavy, state enterprise, Povodí Ohře, state enterprise, Povodí Labe, state enterprise, Povodí Odry, state enterprise and Povodí Moravy, state enterprise. The other key administrator of the minor watercourses is the state enterprise Lesy České republiky.[14]

The main tasks of the basin state enterprises consist of water management and maintenance of the waterworks, protection against floods, providing expert opinions on the

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[11] Feldman, David Lewis, 2012, *Water*. 1. Cambridge, UK : Polity.

[12] Information on Earth's water - National Groundwater Association, 2013. *Ngwa.org* [online],

[13] Správci vodních toků (Voda, eAGRI), 2017. *Eagri.cz* [online],

[14] Správci vodních toků (Voda, eAGRI), 2017. *Eagri.cz* [online],

intentions of investors in the water basin, measuring the groundwater and surface water levels, and monitoring water quality.[15]

3.1.3 Water pricing

Global political debates about water economics are permeated with complicated concerns. One of the main issues of the discussion is the private versus public good aspect of various water services and dealing with the externalities these services produce. Another one is the separation of water sources and their management from the provision of water services itself. And stemming from that is the problem of how to provide the financing of water resources management and services, and the impact of pricing water resources and services for revenue.[16]

According to the 1st recital of the European Union Water Framework Directive: "Water is not a commercial product like any other but, rather, a heritage which must be protected, defended and treated as such".[17] And yet, the accessibility of drinking water and its price is a global issue. Even in most OECD countries, balancing the environmental, social, and financial objectives in water pricing strategies is a challenge. One of the increasing trends however, is both industries and households paying the true cost of the consumed water. This is achieved through tariffs, which are better indicators of the real consumption and treatment costs.[18]

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[15] Profile of the State public enterprise, 2013. *Povodí Vltavy, státní podnik* [online],

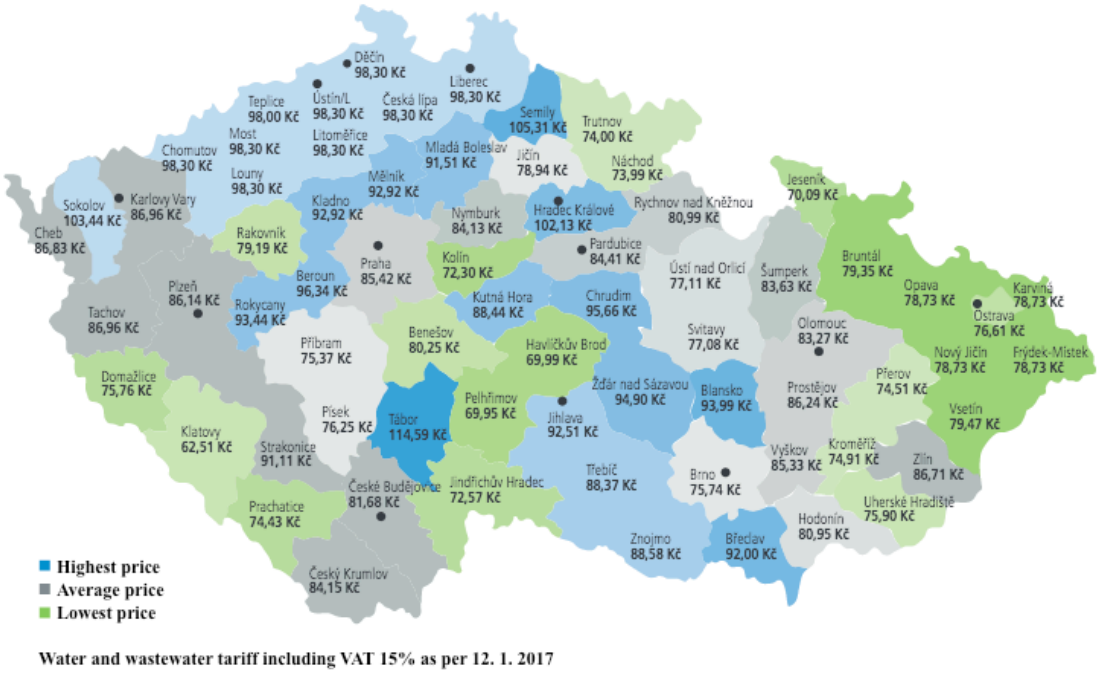
[16] OECD, 2009, *Managing Water for All: An OECD Perspective on Pricing and Financing* [online].

[17] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, 2000. *Eur-lex.europa.eu* [online],

[18] Young, Robert Alton, 2005, *Determining the economic value of water*. Washington, DC : Resources for the Future.

In the Czech Republic, a two-part tariff model is used. Meaning that in some regions, a fixed price is added to the flexible component of the final price. The flexible price is calculated from operational cost, a profit margin and a regulated tariff. An important influence on the final price is also the commendation of the World Health Organization that states that the price should not surpass 2% of an average household income. The fixed component is a flat service charge for being connected to the water lines. The current prices for 2017 can be seen in the map in Figure 1.[19]

Figure 1 - Water prices in the Czech Republic for 2017

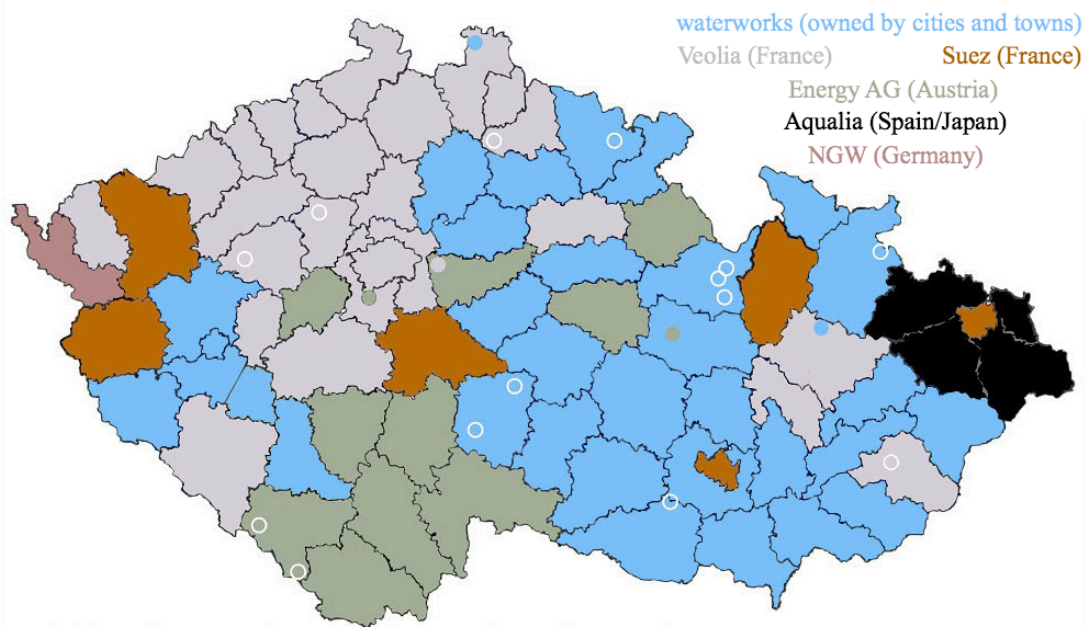


Source: adapted from Prokop, M.,Vodárenství.cz (2017)[20]

[19] Prokop, Martin, 2017, Jak je tvořena cena vodného a stočného v ČR | Vodárenství.cz. *Vodárenství.cz* [online].

[20] Prokop, Martin, 2017, Jak je tvořena cena vodného a stočného v ČR | Vodárenství.cz. [online]

Figure 2 - Waterworks in the Czech Republic by owner



Source: adapted from Novotný, Ing., Pravdaovode.cz (2016)[21]

The waterworks responsible for providing tap water in the Czech Republic can be divided into ones owned by cities and towns, and privately owned waterworks. This can be seen in Figure 2. The owner of the waterworks is not only responsible for the management and distribution of tap water, but also sets the price of the service. In some cases, a mixed model is in practice, where the distribution network itself is owned by the city but the water provided belongs to a foreign concern. In this case, the private company sets the price. However, the prices are always regulated by the state, regardless of the ownership.[22]

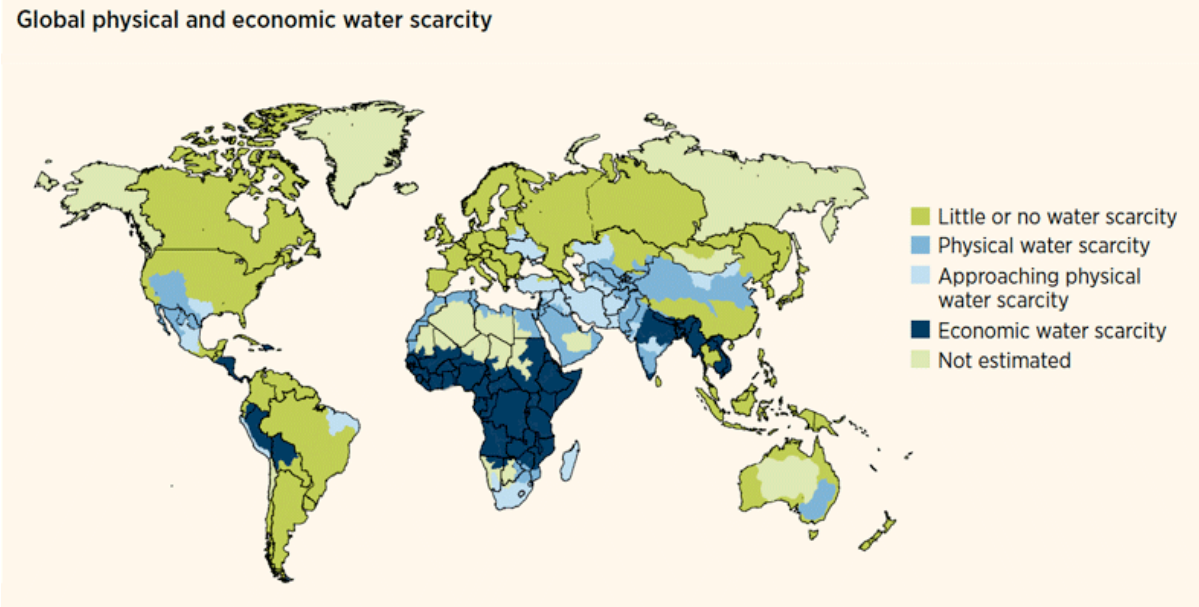
[21] Novotný, Ing., 2016, Srovnání vodáren v rukou měst a koncernů. *Pravdaovode.cz* [online]

[22] Prokop, Martin, 2017, Jak je tvořena cena vodného a stočného v ČR | Vodárenství.cz. *Vodárenství.cz* [online].

3.1.4 Water scarcity

As the global population grows, so does its need for water. According to the 2016 UNESCO report, 1 in 10 people are still without an access to safe water. In some parts of the world, dramatic differences between the wet and dry seasons can lead to a seasonal variation in water demand and supply. This, and the water stress during the dry periods, can be concealed by the annual averages of water availability. Changes in weather are however only one of the elements influencing water deficiency. Water scarcity is globally influenced by various causes and in multiple aspects. [23]

Figure 3 - Global physical and economic water scarcity



Source: World Water Assessment Programme Report (WWAP), 2016.

One is the physical water scarcity, usually from natural causes, as mentioned before. Another one is an economic water scarcity, where because of technical or financial restraints, the infrastructure is lacking. The estimated global economic and physical scarcity can be seen in Figure 3. The third type is an institutional water scarcity. When the

[23] WWAP, 2016, *The United Nations World Water Development Report 2016* [online].

institutions in place fail to ensure secure, stable and equitable water supply. Furthermore, the availability of water is always highly dependent on the quality of the water. Low quality water may not be appropriate for consumption and the cost of treatment may be prohibitive.[24]

3.1.5 Water consumption

The world population is expected to increase by 33% by 2050, going from 7 billion to 9.3 billion. In that same period, food demand will rise by 60%. The increasing global standard of living and various population dynamics are forcing production and consumption of goods and services to escalate. This of course includes water.[25]

The demand for water-intensive products, for instance meat, has a tendency to increase with economic development. This leads to a rise in agricultural water demand. The population and economic growth also generate a growth in energy demand, which is water-intensive as well, and amplify the problem of providing quality water to more people. While the water usage by different sectors is in general based on estimates, and not actual measurements, these estimates signify that withdrawals of freshwater rose up globally by roughly 1% per year between the years 1987 and 2000. And because the growth rate was slightly lower over the past 15 years, around 0.6%, it can be assumed that most of the current increase in water use is caused by developing countries.[26]

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[24] De Villiers, Marq, 2003, *Water*. Toronto : M & S.

[25] WWAP, 2016, *The United Nations World Water Development Report 2016* [online].

[26] WWAP, 2016, *The United Nations World Water Development Report 2016* [online].

3.2 Tap and bottled water

The subsequent chapter concentrates on further details of providing tap and bottled water, and presenting the main types of bottled water available in the Czech Republic.

3.2.1 Tap water

In the majority of developed countries, municipal water usually comes from rivers, lakes, large wells or other, both natural and man-made, reservoirs. Most cities and towns then process the water and pipe it to the customers.[27]

The type and amount of treatment needed to make the water safe for human consumption depends on the source and quality of the water. In the Czech Republic about half of the water provided by the waterworks comes from underground sources. The remaining half is surface water, usually from water reservoirs or the upper reaches of rivers, where the water is not yet polluted. The vicinity of these sources is strictly guarded and placed under the so-called protective zone of water resources. In some cases, the water going into the supply system is a mix of both underground and surface water.[28]

Before surface water can be deemed potable it needs to be purified. This is usually done by adding a coagulating agent, aluminium sulphate, which has the ability to bind impurities into bigger clumps. These are afterwards filtered out through sand filters. All the chemicals used for the decontamination of water are carefully controlled by the law and have to meet a number of requirements regarding the safety of their use. Chlorine is typically added for hygienic reasons, whereas some water treatment plants use ozone to improve the taste of the purified water.[29]

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[27] Types of Water - Municipal | IBWA | Bottled Water, 2017. *Bottledwater.org* [online],

[28] Proč kohoutková? - Kohoutková, 2017. *Kohoutková* [online],

[29] Gleick, Peter H, 2014, *Bottled and Sold*. 1. Washington DC : Island Press.

3.2.2 Bottled water

Since the early 1990s, there has been a growing need for a drinking water that can be trusted by the costumers. During the last decade the demand for bottled water has steadily increased worldwide. This tendency can be observed on a global scale, but the rate at which it grows varies from country to country. For example, in Eastern European countries, per capita consumption of bottled water has increased by about 13% per year from 1997 to 2004. In comparison, in Western Europe and in the USA, the consumption increased at a rate of 6% per year. Subsequently, bottled water has become the most rapidly growing sector of non-alcoholic beverages on the market. Paradoxically, the quality and standards of tap water have also risen substantially over the last decade, and a rather large fraction of the produced bottled water (around 40-60%) is made up of packaged tap water.[30]

Bottled water however cannot be just any water in a bottle. It is considered a consumer food product, and as such has strict standards of identity. The type and source of the water must always be clearly printed on the label. In case of a municipal source, after the water reaches the bottling factory and before it is sold to customers, it goes through several purifying processes. For instance, ozonizing, distillation, deionization or reverse osmosis.[31]

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[30] Doria, Miguel F., 2006, Bottled water versus tap water: understanding consumers' preferences. *Journal of Water and Health* [online].

[31] Gleick, Peter H, 2014, *Bottled and Sold*. 1. Washington DC : Island Press.

Table 2 - Main types of bottled water

WATER	DRINKING (TABLE and FLAVOURED)	INFANT (LOW SODIUM)	NATURAL MINERAL	SPRING
SOURCE	Surface or underground	Underground	Underground	Underground
ALLOWED TREATMENT	Allowed	Only addition of CO_2	Filtration and addition of CO_2	Filtration and addition of CO_2
DISINFECTION	Allowed	Only UV rays	Ozonizing allowed	Ozonizing allowed
BENEFITS	Variability of flavours	Guaranteed safe for infants	Healthy minerals	Variability of flavours and fizziness

Source: author's own work, 2017

There are several types of bottled water available on the market, but the 4 most common ones in the Czech Republic are drinking bottled water (table or flavoured), infant water, natural mineral, and spring water (see Table 2).

Drinking bottled water, sometimes also called table water, is any kind of bottled water that was treated by one of the processes for water purification and deemed safe for consummation. The water can be artificially flavoured.[32]

Spring water is water from an underground spring. It must be collected directly at the spring or through a borehole. When collected using an outside force, the water must have all the same characteristics and qualities as the water directly from the spring.[33]

[32] Types of Water - Bottled | IBWA | Bottled Water, 2016. *Bottledwater.org* [online],

Infant water is simply the water from underground sources with the highest quality. It has to fulfil the strictest limits and be naturally low in sodium. It also cannot be filtered or otherwise altered; the only permitted treatment is addition of CO_2 and using UV rays for disinfection.[34]

Natural mineral water is set apart from the other types of bottled water by its natural level of mineral and trace elements. It is natural water with no less than 250 parts per million dissolved solids. No minerals can be added to this type of water.[35]

Sparkling water is a type of water that, following treatment and possible addition of CO_2, has the same level of carbon dioxide that it had at its source. Sparkling can be an added label to the previous types, for example sparkling spring water or sparkling mineral water. [36]

Some other types of regularly available water include artesian water, sourced from artesian wells, or various artificially flavoured water, both sparkling and otherwise.[37]

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[33] Types of Water - Bottled | IBWA | Bottled Water, 2016. *Bottledwater.org* [online],

[34] Mgr. Gálová, Kateřina, 2012, Balená voda - jakou vybrat. *Balena-voda.eu* [online].

[35] Types of Water - Bottled | IBWA | Bottled Water, 2016. *Bottledwater.org* [online],

[36] Types of Water - Bottled | IBWA | Bottled Water, 2016. *Bottledwater.org* [online],

[37] Types of Water - Bottled | IBWA | Bottled Water, 2016. *Bottledwater.org* [online],

4 Practical Part

The practical portion of this thesis consists of two parts. The first part is an evaluation of a survey research on customers' preferences in bottled water consumption and expenditures. And the second part is a statistical analysis of the differences in pricing of tap water in restaurants in the Czech Republic.

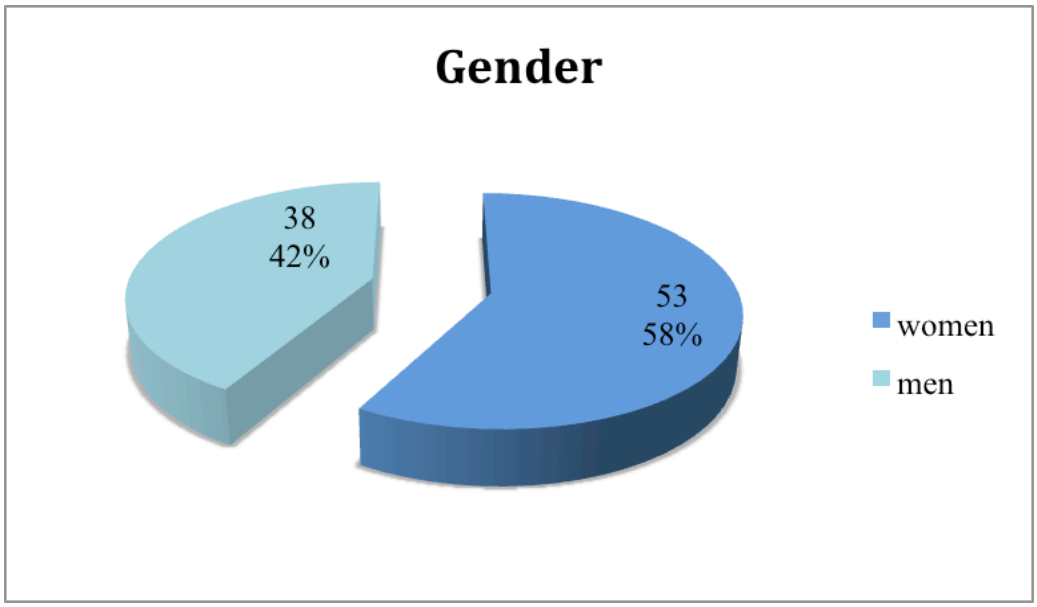
4.1 Preference survey

An electronic form of a questionnaire was used to gather data on customers' preferences. This questionnaire was available on survio.com and a direct link to it was shared on social sites such as Facebook. The survey consisted of 10 questions in total, the first 6 to determine selected characteristics of the respondents and the remaining 4 to gather information about their preferences. In total 91 respondents took part in this survey. The results are elaborated on in detail and supplemented with graphs, and the full questionnaire is attached as Appendix 1.

4.1.1 Characteristics of the selected sample

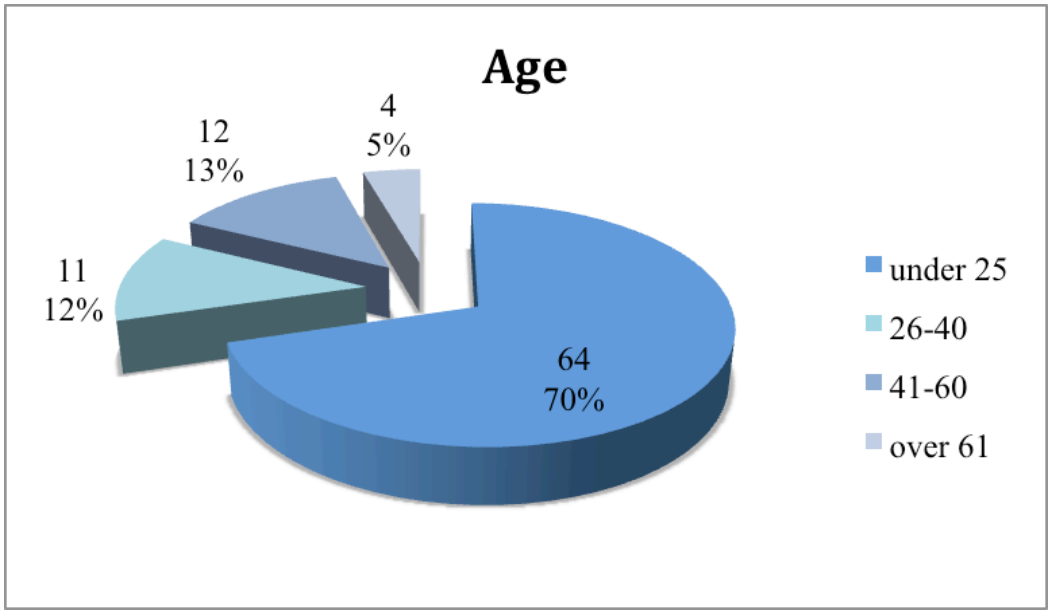
As stated before, a total number of 91 respondents filled in the survey. Out of these, 53 (58.2%) were women and 38 (41.8%) men. Over 70% of the respondents, 64 people in total were young people under 25. Remaining age groups, divided according to ČSÚ, were represented thus: 26-40: 12.1%, 41-60: 13.2%, and over 61: 4.4% (See figures 4 and 5).

Figure 4 – Gender of participants



Source: author's own work, 2017

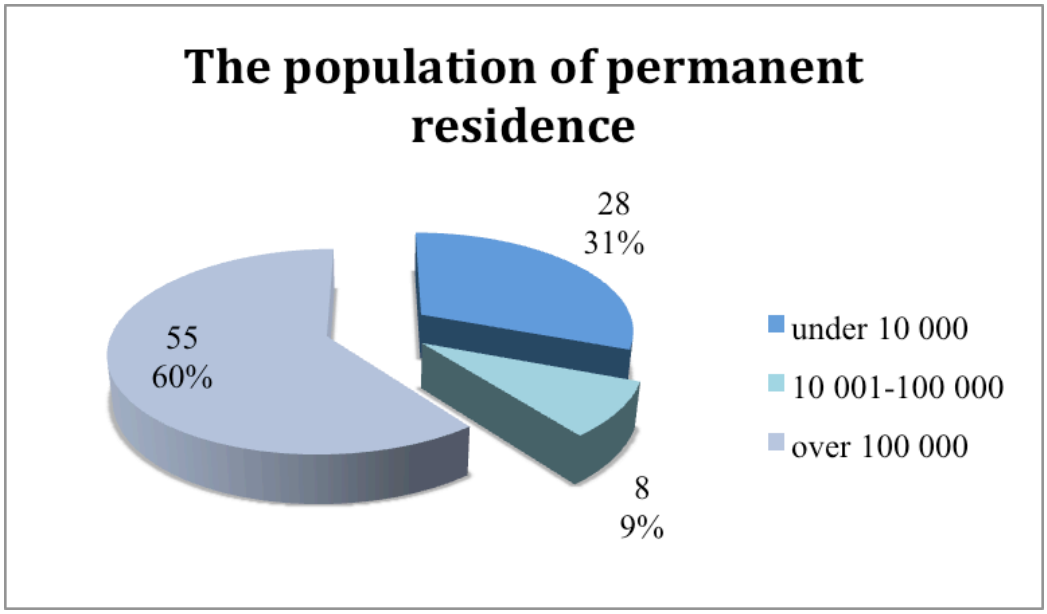
Figure 5 - Age of participants



Source: author's own work, 2017

Most respondents were from bigger cities, with population over 100 000: 55 (60.4%). Followed by 28 (30.8%) from small towns with under 10 000 inhabitants, and only 8 people (8.8%) from medium sized towns with a population between 10 001 and 100 000 (see Figure 6).

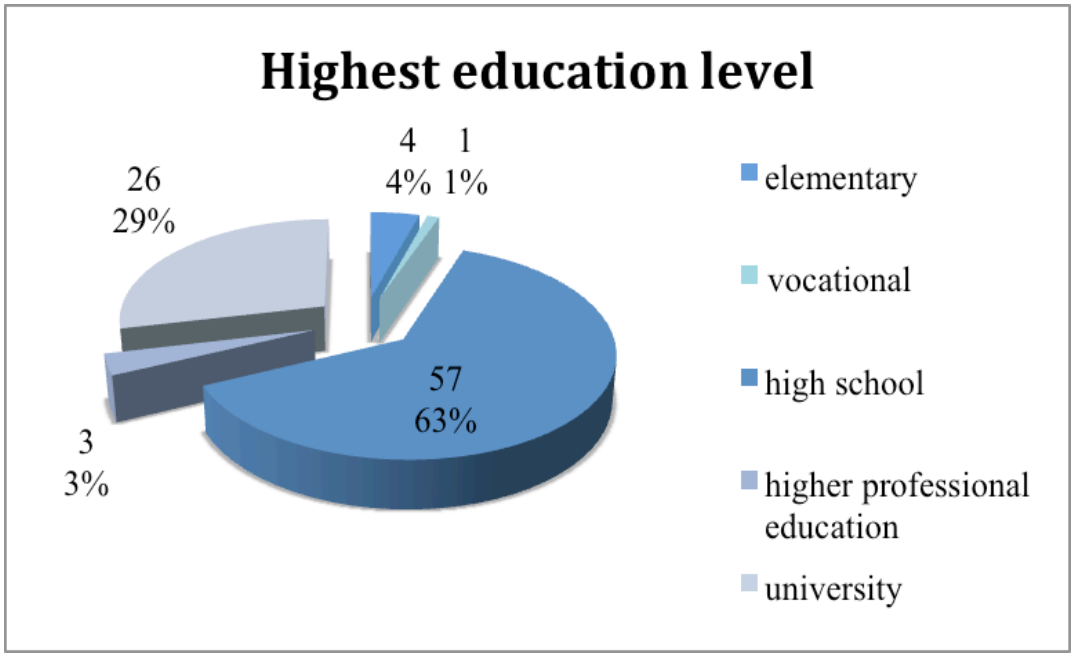
Figure 6 - The population of permanent residence



Source: author's own work, 2017

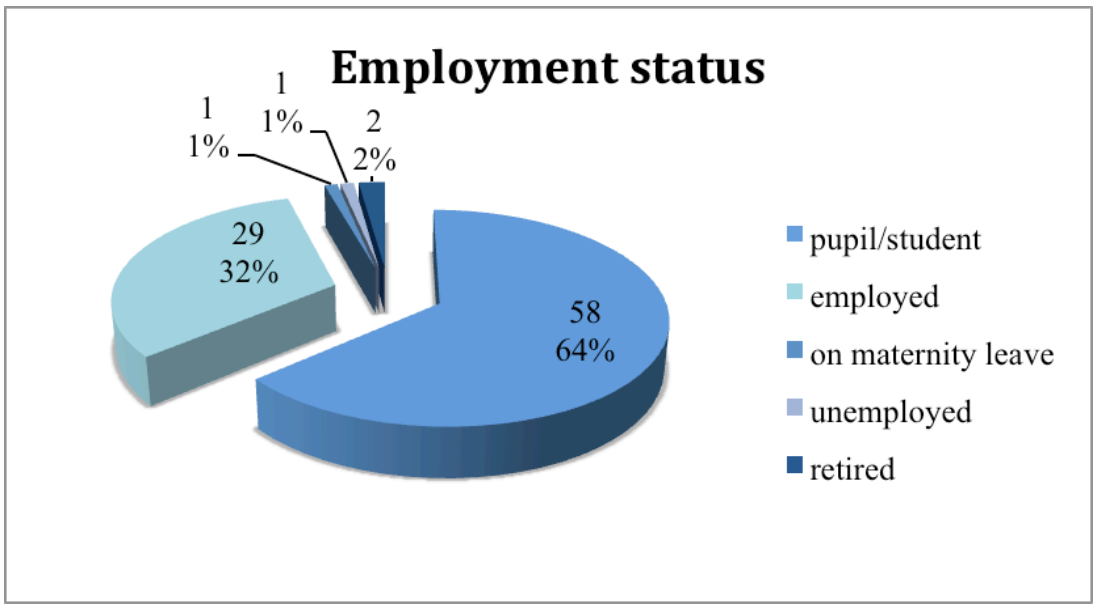
Highest completed education level of the respondents was as follows: elementary school – 4 (4.4%), vocational school – 1 (1.1%), high school with a leaving exam – 57 (62.6%), higher professional education – 3 (3.3%), and university degree – 26 (28.6%). The breakdown can be seen in Figure 7. Question number five gave the respondents the option to choose from five different employment statuses: pupil/student, employed, on maternity leave, unemployed, and retired. As can be seen from the results in Figure 7, most of the respondents were pupils or students. This corresponds with the results from question one, regarding the age of the answerers. Only one respondent was on maternity leave, one unemployed, and only two participants were retired.

Figure 7 - Highest level of education of participants



Source: author's own work, 2017

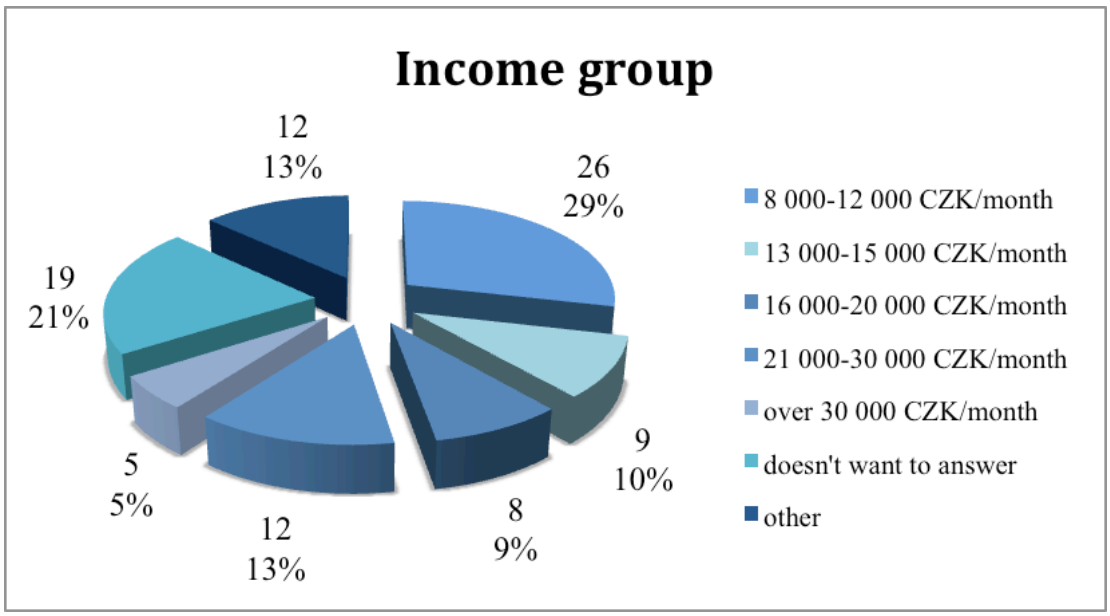
Figure 8 - Employment status of participants



Source: author's own work, 2017

The next question was focused on sorting people into different income groups. The biggest fraction of the answers, 26 people in total (29%), admitted to a monthly income between 8 000 and 12 000 CZK. The other income groups were divided thusly: 13 000-15 000 CZK/month – 9 (10%), 16 000-20 000 CZK/month – 8 (9%), 21 000-30 000 CZK/month – 12 (13%), over 30 000 CZK/month – 5 (5%), and other – 12 (13%). This question also included the option of not answering, which was chosen by 19 respondents (see Figure 9).

Figure 9 - Income group of participants

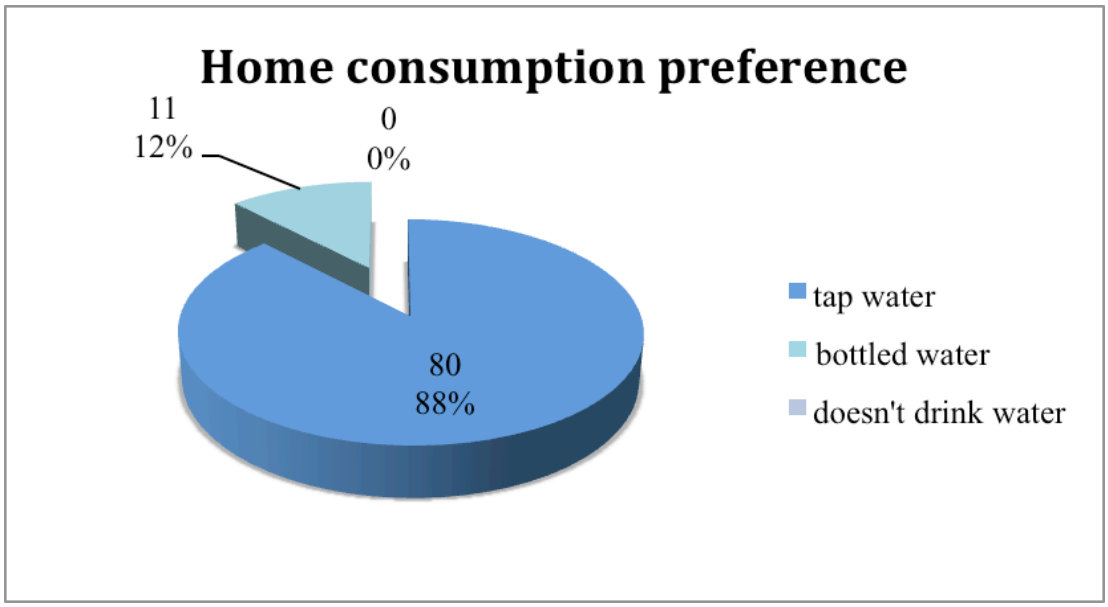


Source: author's own work, 2017

The remaining four questions were focused on costumer's preferences in regards to their consumption of water. Question about their home consumption preferences revealed that a whole 88% of participants, 80 people in total, prefer to drink tap water at home. Only 11 people (12%) chose bottled water. Based on their answers, all the respondents drink water at home (see Figure 10).

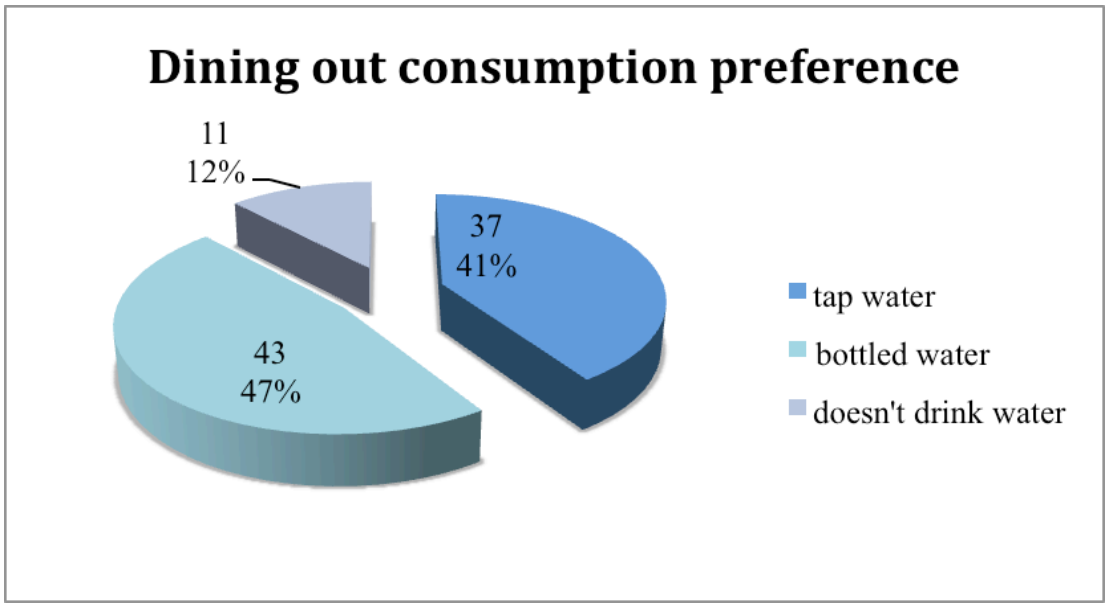
In contrast to their preferences at home, only 41% of respondents, meaning less than half from the previous question, choose to drink tap water when dining out. In this case, bottled water is clearly the favoured option, with 47% of participants choosing it over the other possible answers. According to their answers, 12% of respondents do not drink water when dining out (see Figure 11).

Figure 10 - Home consumption preference



Source: author's own work, 2017

Figure 11 - Dining out consumption preference

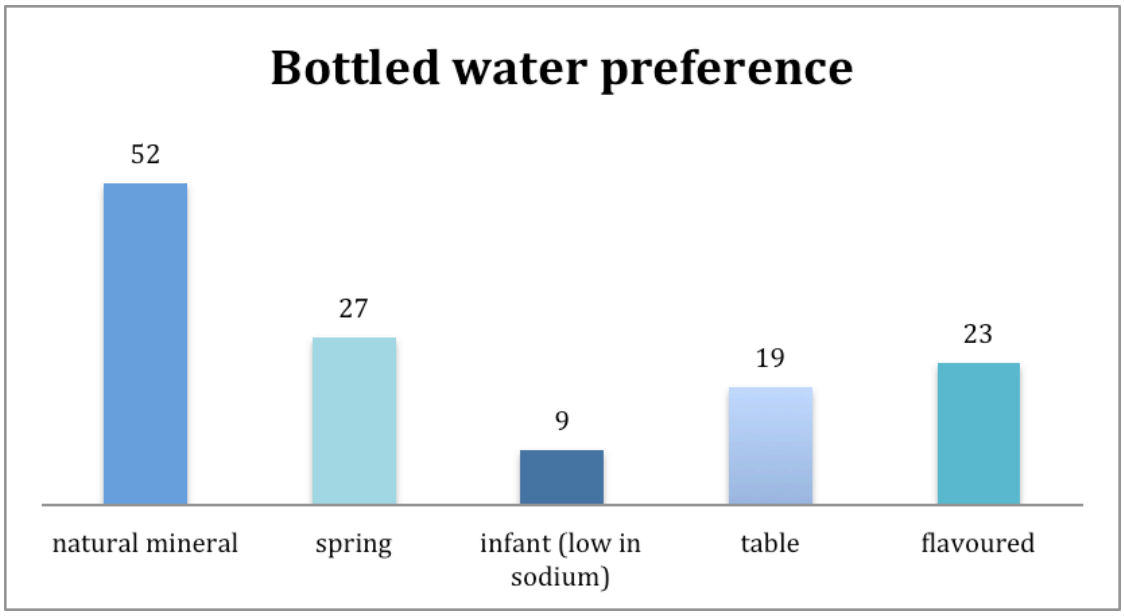


Source: author's own work, 2017

When asked to choose from the five most commonly available types of bottled water, the participants were allowed to pick more than one option. They answered as follows: natural mineral water – 52, spring water – 27, water suitable for infants – 9, table water – 19, and flavoured water – 23. The distribution of these answers is visualized in Figure 12.

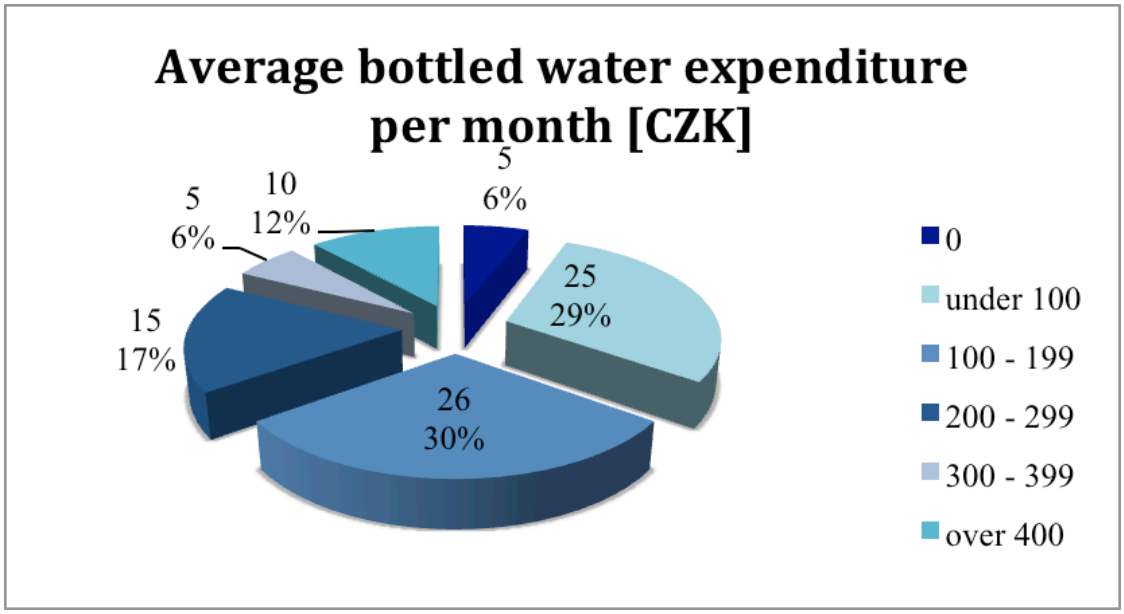
The last question in the survey was focused on the participants' monthly expenditure on bottled water. This question was an open one, allowing the respondents to write in their own answer. In total 86 of them answered. Their answers were then evaluated and divided into six categories based on the recorded amount. This allotment is depicted in Figure 13.

Figure 12 - Bottled water preference



Source: author's own work, 2017

Figure 13 - Average bottled water expenditure per month



Source: author's own work, 2017

4.1.2 Regression analysis

The next step was to find out if different personal characteristics of the respondents influence their bottled water expenditure per month and if so, then by how much. To measure this, multiple linear regression analysis was computed in Microsoft Excel. The full output data is attached as Appendix 2.

First, to make them usable for the analysis, the categorical data from questions one to five of the survey had to be converted into numerical as follows:

Q1: gender

- women = 1
- men = 0

Q2: age

- under 25 = 1
- 26-40 = 2
- 41-60 = 3
- over 61 = 4

Q3: the size of the population of permanent residence

- under 10 000 = 1
- 10 001-100 000 = 2
- over 100 000 = 3

Q4: highest completed education level

- elementary school = 1
- vocational school = 2
- high school with a leaving exam = 3
- higher professional education = 4
- a university degree = 5

Q5: current employment status

- pupil/student = 1
- employed = 2
- on maternity leave, unemployed or retired = 3

Secondly, 5 of the 91 collected data records had to be eliminated from the computation, because they did not include the expenditure data points. Then the data was finally usable for input into the regression analysis.

A null hypothesis and its corresponding alternative hypothesis were established to assess the significance of the parameters. H_0: $\beta_j = 0$ and H_1: $\beta_j \neq 0$. The level of significance α was appointed at 0,05.[38] The p-values of the parameters can be seen in the last column in Figure 14.

[38] Lane, David M., [no date], Regression. *Online Statistics Education: A Multimedia Course of Study* [online].

Figure 14 - MLR parameter results

	Koeficienty	*Chyba stř. hodnoty*	*t Stat*	*Hodnota P*
Hranice	245,5285385	89,24178511	2,751273277	0,007340198
gender	-28,82497403	37,15374592	-0,775829552	0,44013718
age	7,232405615	30,74222635	0,235259657	0,814608375
population	0,395328968	19,15642762	0,020636884	0,983586703
education	-4,523179524	19,68189112	-0,229814274	0,818822682
employment	-46,82862543	47,1734891	-0,99268946	0,323854399

Source: author's own computation, 2017

Because all of the p-values of the parameters are higher than α, the null hypothesis has to be accepted and the multiple linear regression analysis is unnecessary. Meaning that all of the parameters are statistically insignificant and there's no correlation between the respondents' age, gender, population of permanent residence, education level or employment status, and the monthly amount of money they spend on bottled water.[39]

4.2 Tap water in restaurants

The second objective of the practical part was to statistically analyse the differences in the price of tap water served in restaurants in the Czech Republic. I had personally collected the data from a sample of 100 restaurants in 44 different towns and cities across the country. The price of the served water was converted into price per litre for an easier comparison between values. The raw data is attached as a table in Appendix 3.

[39] Lane, David M., [no date], Regression. *Online Statistics Education: A Multimedia Course of Study* [online].

4.2.1 Descriptive statistics

First, simple descriptive statistics were used to evaluate the prices in general. There were 100 observations in total, with minimum of 0 and maximum 100. That means that while at least one restaurant offered their tap water completely for free, at least one restaurant provided a litre of tap water for 100 CZK.

The median was 30 CZK/litre. Median is the middle value in a sorted data set, meaning that 50% of the data is lower than its value and 50% is higher.[40] In our case, because the number of observations is an even number, the value lies on the midpoint between the 50th and 51st observation. Indicating that at least 49 restaurants offer a litre of water for less than 30 CZK, while at least 49 of them offer it for more than that.

The arithmetic mean was equal to 34.83, while modus was 20. Modus is the most frequent value in a data set, in this case meaning that the restaurants provided a litre of water for 20 CZK the most. When the mean and modus are different, like in this situation, the data is not spread out symmetrically.[41]

And the last important criterion in the descriptive statistics is the measure of variability, the sample standard deviation. For this data set it equals 21.01084616. Assuming a normal distribution of data, around two-thirds of the values should fall within one standard deviation from the mean, concretely between 13.82 and 55.84.[42] All the descriptive statistical values can be seen in the output from MS Excel in Figure 15.

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[40]Souček, Eduard, 2006, *Statistika pro ekonomy* [online].

[41] Souček, Eduard, 2006, *Statistika pro ekonomy* [online].

[42] Souček, Eduard, 2006, *Statistika pro ekonomy* [online].

Figure 15 - Descriptive statistics of price per litre [CZK]

	price per litre [CZK]
Stř. hodnota	34,83
Chyba stř. hodnoty	2,101084616
Medián	30
Modus	20
Směr. odchylka	21,01084616
Rozptyl výběru	441,4556566
Špičatost	1,03838383
Šikmost	0,889037583
Minimum	0
Maximum	100
Součet	3483
Počet	100

Source: author's own computation, 2017

4.2.2 Regression analysis

In order to further evaluate the differences in the pricing of tap water in restaurants and determine what influences it, multiple linear regression analysis was used. To do so, I had assessed two different parameters that could affect the final price.

The first observed parameter was the size of the city the restaurant was located in. This number was taken from the Czech Statistical Office, based off of the population of municipalities on January 1st, 2016.[43]

The second parameter was any sort of addition to the water. The most common ones were ice, lemon, orange, and/or fresh mint leaves. To make this data appropriate for MLR, it was divided into two categories, extra and nothing, and given numerical values 1 and 0, respectively. Then the regression analysis was run in MS Excel (see Figure 16).

[43] Počet obyvatel v obcích České republiky k 1.1.2016, 2016. *Czso.cz* [online],

Figure 16 - Regression analysis

Regresní statistika	
Násobné R	0,509112
Hodnota spolehlivosti R	0,259195
Nastavená hodnota spolehlivosti R	0,243921
Chyba stř. hodnoty	18,269519
Pozorování	100,000000

	Koeficienty	*Chyba stř. hodnoty*	*t Stat*	*Hodnota P*
Hranice	21,475570	3,064040	7,008906	0,000000
Population	0,000017	0,000003	5,003968	0,000003
Extra	11,230567	3,661026	3,067601	0,002797

ANOVA

	Rozdíl	*SS*	*MS*	*F*	*Významnost F*
Regrese	2,000000	11327,903582	5663,951791	16,969354	0,0000005
Rezidua	97,000000	32376,206418	333,775324		
Celkem	99,000000	43704,110000			

Source: author's own computation, 2017

Once again, the first step was stating the null hypothesis regarding the two parameters and their significance. H_0: $\beta_j = 0$ and H_1: $\beta_j \neq 0$. Level of significance α was equal to 0.05. As we can see in the last column of the output, the p-values for population and extra were 0.000003 and 0.002797, respectively. Both are smaller than α and therefore both are statistically significant, rejecting the null hypothesis. [44]

Next step is the test of the correlation between the data and the computed model. The coefficient of determination R^2 indicates how much the changes in parameters influence the change in the criterion variable. The value of the coefficient is always between 0 and 1. The bigger it is, the more correlated is the model. In this case the value is 0.259195,

[44] Lane, David M., [no date], Regression. *Online Statistics Education: A Multimedia Course of Study* [online].

meaning that around 25% of the changes in the price are influenced by the changes in population and added ingredients.

In order to test the overall statistical significance of the model the F-test is used. First the null hypothesis and its alternative have to be stated. H_0: R^2 is statistically insignificant and H_1: R^2 is statistically significant. The F-test value is 16.969354 and its significance equals 0.0000005. Therefore the null hypothesis is rejected.[45]

The final equation then looks like this:

$y = 21.475570 + 0.000017 * x_1 + 11.230567 * x_2 + e_i$

Where: y ……price of the water per litre

x_1 ……population of the city

x_2 ……extra ingredients

e_i ……error

The estimated relationships are then clear from the equation. If the population of the city increases by one, the price will increase by 0.000017. And adding extra ice or a slice of fruit increases the price by 11.230567. Of course, with this relatively small sample size and given how simplified the model is, it is better to only consider the strength and direction of the relationships between the variables, rather than concrete numbers.[46]

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[45] Lane, David M., [no date], Regression. *Online Statistics Education: A Multimedia Course of Study* [online].

[46] Lane, David M., [no date], Regression. *Online Statistics Education: A Multimedia Course of Study* [online].

5 Conclusion

One of the main objectives of this thesis was to compare the production of bottled and tap water. The first segment of the theoretical part explained all the basic terminology concerning water management and supply, such as drinking water, water tariff, and water supply. The global water resources were discussed in detail, with a particular focus on the water sources and waterworks in the Czech Republic. The question of ownership of the water resources in the Czech Republic was also answered and the main principles of water pricing were further explained as well. The two-part tariff model of water pricing in the Czech Republic was defined and a figure with the latest water prices for 2017 was included.

The following subchapters dealt with water scarcity and water consumption. The different types of water scarcity were explained and illustrated on a global view, and the different issues concerning the adequate supply of drinkable water were discussed. Moreover, the worldwide rise in water demand and predictions for the future of water management were debated.

The second part of the literature review concentrated specifically on the particulars of production of tap and bottled water. The sources of tap water were once again mentioned, as well as the different industrial treatments used to make tap water safe for human consumption. Then the different types of bottled water available on the market were considered.

The practical part of the thesis was set up to find out two things. First, what are customers' preferences in tap and bottled water consumption, and how much their demographics influence their bottled water expenditure. And second, what factors influence the pricing of tap water served in restaurants, and by how much.

The customers' preferences were evaluated using an electronic survey. The analysis of the results and the generated graphs show there is quite a strong variety in customers' preferences, both in case of tap as well as bottled water. The collected data sample was however unsuitable for a multiple linear regression analysis and therefore we cannot say with any surety how much the demographics influence their monthly expenditure on bottled water.

For the final part of the practical section, I had personally collected the data from a total of one hundred restaurants in 44 different cities across the Czech Republic. The measured values were price of tap water per litre, population of the city or town that the restaurant was located in, and any sort of addition to the water, for example ice. After evaluating the data and running a multiple linear regression analysis, a model of dependency was created. It was discovered that the price of the served water does indeed depend on both of the observed parameters, albeit to a different degree. The effect of the population on price is considerably smaller than the effect of the additives. Thus the practical part was successfully completed.

To summarize, this thesis offered a general overview of the issues of water trade and management, compared the production of bottled and tap water, and inspected the different factors influencing the final price of tap and bottled water.

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7 Appendix

Appendix 1 – Survey

Balená voda

Dobrý den,

jsem studentkou České Zemědělské univerzity v Praze a touto cestou Vás prosím o vyplnění následujícího krátkého dotazníku na téma balené vody. Cílem tohoto dotazníku je zjistit, jaký mají spotřebitelé na českém trhu přístup k balené vodě.

Předem děkuji za Vaši ochotu a čas strávený při vyplňování tohoto dotazníku,

Tereza Zouharová

1

Pohlaví:

- Žena
- Muž

2

Věk:

- do 25
- 26-40
- 41-60
- 61 a více

3

Počet obyvatel trvalého bydliště:

- do 10 000
- 10 001-100 000
- nad 100 000

4

Nejvyšší dosažené vdělání:

- Základní
- Střední s vyučením
- Střední s maturitou
- Vyšší odborné
- Vysokoškolské

5

Váš statut je:

- Žák/student
- Zaměstnaný
- Na mateřské dovolené
- Nezaměstnaný
- Důchodce

6

Do které příjmové skupiny patříte?

- 8 000 – 12 000 Kč / měsíčně
- 13 000 – 15 000 Kč / měsíčně
- 16 000 – 20 000 Kč / měsíčně
- 21 000 – 30 000 Kč / měsíčně

- ○ 30 000 a více Kč / měsíčně
- ○ nechci odpovědět
- ○ jiná:

Napište odpověď

*Zbývá **100** znaků*

7

K běžné domácí konzumaci preferujete vodu:

- ○ z vodovodu
- ○ balenou
- ○ nepiji vodu

8

V restauracích, kavarnách a dalších podobných zařízeních preferujete vodu:

- ○ z vodovodu
- ○ balenou
- ○ nepiji vodu

9

Balené vody preferujete:

- ☐ přírodní minerální
- ☐ pramenité
- ☐ kojenecké

- [ ] pitné
- [ ] ochucené

10

Kolik v průměru zaplatíte za balenou vodu za měsíc?

Napište číslo

*Zbývá **20** znaků*

Appendix 2 – Regression analysis output

Regresní statistika	
Násobné R	0,167429285
Hodnota spolehlivosti R	0,028032565
Nastavená hodnota spolehlivosti R	-0,032715399
Chyba stř. hodnoty	157,4570417
Pozorování	86

ANOVA

	Rozdíl	*SS*	*MS*	*F*	*Významnost F*
Regrese	5	57203,85445	11440,77089	0,461456867	0,803784292
Rezidua	80	1983417,599	24792,71999		
Celkem	85	2040621,453			

	Koeficienty	*Chyba stř. hodnoty*	*t Stat*	*Hodnota P*	*Dolní 95%*	*Horní 95%*	*Dolní 95,0%*	*Horní 95,0%*
Hranice	245,5285385	89,24178511	2,751273277	0,007340198	67,93172944	423,1253476	67,93172944	423,1253476
gender	-28,82497403	37,15374592	-0,775829552	0,44013718	-102,7632835	45,11333539	-102,7632835	45,11333539
age	7,232405615	30,74222635	0,235259657	0,814608375	-53,94657348	68,41138471	-53,94657348	68,41138471
population	0,395328968	19,15642762	0,020636884	0,983586703	-37,72717625	38,51783419	-37,72717625	38,51783419
education	-4,523179524	19,68189112	-0,229814274	0,818822682	-43,69139043	34,64503138	-43,69139043	34,64503138
employment	-46,82862543	47,1734891	-0,99268946	0,323854399	-140,7068589	47,04960805	-140,7068589	47,04960805

Appendix 3 – Tap water in restaurants

Restaurant	City	Population	Extra	notes	price per litre [CZK]
U všech kukaček	Modrava	72	1	lemon	20
Restaurace Radnice	Třebenice	437	0	nothing	20
Hospoda Bubovice	Bubovice	490	0	nothing	20
Nový Rybník	Obořiště	643	0	nothing	35
Tradiční Hostinec Vříšť	Sněžné	703	1	lemon	30
Kravinec	Dnešice	828	1	ice and lemon	0
Starý Dvůr	Nové Dvory	868	0	nothing	20
Hotel Praha	Potštejn	940	1	mint and lemon	18
Sokolovna - Peklo	Dolní Loučky	1237	1	ice and lemon	20
Club Zbraslav	Zbraslav	1283	1	lemon	30
Pietro	Ondřejov	1592	1	ice and lemon	70
OtavArena	Písek	1825	1	lemon	15
H-resort	Kunčice pod Ondřejníkem	2299	1	mint and lemon	20
Hotýlek u Pekina	Zlaté Hory	3944	1	mint and lemon	25
Za Lyžárnou	Jilemnice	5515	1	lemon	20
Taverna Riwa	Kostelec n. Orlicí	6184	1	lemon	20
Luna restaurant	Černošice	6914	0	nothing	40
Staré Časy	Hořice	8583	0	nothing	30
U Krbu	Polička	8783	1	lemon	50
U Švelchů	Sušice	11130	1	lemon	20
Zámek Hrádek	Sušice	11130	0	nothing	20
Zlatá Růže	Boskovice	11566	1	lemon	20
Hotel Slavia	Boskovice	11566	1	lemon	35
Mlýn Zlatá Koruna	Český Krumlov	13160	0	nothing	60
Na Kempu	Poděbrady	14219	1	ice and lemon	50
U Pastvů	Dvůr Králové n. Labem	15882	1	lemon	30
Písečná	Rožnov p. Radhoštěm	16541	0	nothing	20
Cihelna	Žatec	19271	0	nothing	25
U Kata	Kutná Hora	20341	0	nothing	17
Fabrika pizzeria	Havlíčkův Brod	23234	1	ice and lemon	39
Graphic hotel	Nový Jičín	23571	1	lemon	32
Biskupský pivovar	Litoměřice	24106	1	lemon	25
U Starýho kozla	Příbram	33058	1	lemon	27
Škochův Dům	Tábor	34641	0	nothing	20

The Pub	Tábor	34641	0	nothing	66
Lidový dům	Třinec	35760	1	lemon	30
Wildcook	Česká Lípa	37158	1	lemon	48
Vista	Přerov	43994	1	lemon	30
Sedlecká Pivnice	Karlovy Vary	49326	0	nothing	17
Hospůdka Ohře	Karlovy Vary	49326	0	nothing	18
Zahrada	Teplice	49959	0	nothing	0
Hospůdka Hlubina	Teplice	49959	1	ice and lemon	29
Rosignano	Pardubice	89638	0	nothing	20
U Bílého Koníčka	Pardubice	89638	1	lemon	30
Potrefená Husa	Pardubice	89638	1	ice and lemon	58
U Sokola	Hradec Králové	92891	0	nothing	0
Satchmo	Hradec Králové	92891	0	nothing	20
U Motlů	Hradec Králové	92891	0	nothing	21
Inflagranti	Hradec Králové	92891	1	lemon	30
Fascila	Hradec Králové	92891	0	nothing	30
Pegast	České Budějovice	93513	0	nothing	30
Pegast	České Budějovice	93513	0	nothing	30
Moravská restaurace	Olomouc	100154	0	nothing	0
Svijanská hospůdka u Lva	Liberec	103288	0	nothing	20
Zoo 1320	Liberec	103288	0	nothing	30
All´Allegria Pizzeria	Liberec	103288	0	nothing	50
Bar, který neexistuje	Brno	377028	0	nothing	0
Jedna Báseň	Brno	377028	0	nothing	0
Avia Café	Brno	377028	0	nothing	10
Charlie's	Brno	377028	0	nothing	20
Lazza	Brno	377028	0	nothing	20
Kadlcův Mlýn	Brno	377028	1	lemon	30
Pivní Panorama	Brno	377028	1	ice and lemon	35
Pivní Sady	Brno	377028	1	ice and lemon	35
Comodo	Brno	377028	1	lemon	35
Vivobene Gusto	Brno	377028	1	lemon	35
Namaskar	Brno	377028	1	ice and lemon	40
La Strada	Brno	377028	1	ice, lemon and mint	40
Veselá kavárna	Brno	377028	1	lemon	44
Goa	Brno	377028	1	mint and lemon	50
Forhaus	Brno	377028	0	nothing	55
U Libušky	Brno	377028	0	nothing	60

Light of India	Brno	377028	1	mint and lemon	100
Peperoncino	Prague 7	1267449	0	nothing	0
Můj šálek kávy	Prague 8	1267449	0	nothing	20
Severka	Prague 9	1267449	0	nothing	20
Do Větru	Prague 6	1267449	1	lemon	21
U Daschů	Prague 9	1267449	0	nothing	29
U Švehly	Prague 10	1267449	0	nothing	30
Cafe Decada	Prague 8	1267449	0	nothing	33
Hlučná Samota	Prague 2	1267449	1	ice and lemon	35
Baráčnická Rychta	Prague 1	1267449	0	nothing	37
Ananas Bananas	Prague 3	1267449	0	nothing	39
Pod Lipami	Prague 10	1267449	1	lemon	40
El Pablo	Prague 1	1267449	0	nothing	40
Rotondo	Prague 10	1267449	1	lemon	50
Neklid restaurant	Prague 10	1267449	1	mint and lemon	50
Hanabi	Prague 1	1267449	0	nothing	50
Columna	Prague 4	1267449	0	nothing	50
Bruxx	Prague 2	1267449	1	ice and lemon	58
Pražanka	Prague 11	1267449	1	ice	60
Teodor	Prague 4	1267449	1	ice	60
U Kristiána	Prague 5	1267449	1	ice and lemon	60
U Škopů	Prague 5	1267449	1	ice and lemon	60
Pálavská restaurace	Prague 3	1267449	1	lemon	60
Na Pekařce	Prague 4	1267449	1	ice, lemon and mint	69
Restaurace Hamburg	Prague 7	1267449	1	lemon	80
Historie	Prague 2	1267449	0	nothing	83
Černý Jelen	Prague 1	1267449	0	nothing	90
Obzor	Prague 4	1267449	1	ice and lemon	100