Charles University in Prague

Faculty of Social Sciences
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BACHELOR THESIS

Willingness to pay for mobile internet in the Czech Republic

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Academic Year: **2015/2016**

Declaration of Authorship

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

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Prague, July 29, 2016

Signature

Acknowledgements

The author would like to thank to their supervisor Petr Polák Msc. here, for his comments and suggestions, which motivated and helped them in the understanding and writing of this thesis.

Abstract

The main focus of this thesis is to examine consumers' willingness to pay for mobile internet in the Czech Republic. The data for the estimation were collected via a self-developed online questionnaire. Using the logit model, the factors, which significantly influences the WTP, were identified. These include: the ownership of a smartphone, perceived importance of availability of the internet connection, having a monthly mobile tariff and the way of using mobile applications. Additionally, the price, that the consumers' would be willing to pay for their ideal tariff, is examined and it is shown, that the level of education has a significant negative effect on this price.

JEL Classification	F12, F21, F23, H25, H71, H87
Keywords	WTP, mobile internet, consumer preferences, Czech Republic

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Abstrakt

Tato práce zkoumá ochotu spotřebitelů platit za mobilní internet v České republice. Data pro analýzu byla sesbírána pomocí vlastního online dotazníku. S použitím modelu logit, byly určeny faktory, které mají signifikantní vliv na ochotu platit. Těmito faktory jsou: vlastnictví chytrého telefonu, vnímaná důležitost dostupnosti internetového připojení, využívání mobilního tarifu a způsob používání mobilních aplikací. Dále byla zjištěna cena, kterou by spotřebitelé byli ochotni platit za pro sebe ideální tarif. Ukázalo se, že nejvyšší úroveň dosaženého vzdělání má záporný efekt na tuto cenu.

Klasifikace JEL	F12, F21, F23, H25, H71, H87
Klíčová slova	ochota platit, mobilní internet, preference spotřebitele, Česká republika

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Acronyms

2G Second Generation

3G Third Generation

4G Fourth Generation

APE Average Partial Effect

c-TAM consumer TAM

cdf Cumulative Distribution Function

CTU Czech Telecommunication Office

LAN Local Are Network

LPM Linear Probability Model

LTE Long Term Evolution

MLE Maximum Likelihood Estimator

MNO Mobile Network Operator

ICT Information and Communication Technologies

ITU International Telecommunication Union

LR Likelihood Ratio

OLS Ordinary Least Squares

PEA Partial Effect at the Average

TAM Technology Acceptance Model

VMNO Virtual Mobile Network Operator

WLAN Wireless LAN

WTA Willingness to Accept

WTP Willingness To Pay

Bachelor Thesis Proposal

Author	Kateřina Doskočilová
Supervisor	Petr Polák MSc.
Proposed topic	Willingness to pay for mobile internet in the Czech Republic

Topic characteristics The telecommunication industry is undergoing big changes. New technologies open the market to new players who provide different services and that is something that the existing providers (e.g. mobile operators) have to adapt to. Their revenues from traditional mobile services (calling and text messaging) are declining and therefore they need to compensate them with revenues from mobile internet. In the Czech Republic, the prices of mobile services are generally higher, compared to other European countries, and the usage of mobile internet is considerably lower. In this thesis, consumers' preferences for mobile services in the Czech Republic will be examined.

Research Questions The aim of this thesis will be to answer these following research questions:

1. What is the willingness to pay for mobile internet in the Czech Republic?

2. What are the factors influencing this willingness to pay?

Methodology The data will be collected by a self-developed online questionnaire asking about consumers' preferences and behaviour concerning mobile services, especially mobile internet.

Outline

1. Introduction
2. Literature Review

3. Theoretical Concepts
4. Data and Empirical Model
5. Results
6. Conclusion

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Author Supervisor

Chapter 1

Introduction

The telecommunication services have been going through substantial changes in the past few years. While only ten years ago, the biggest news in mobile services were MMSs, now everything revolves around mobile internet data. Mobile operators have to react to these changes, considering that due to unlimited tariffs and prices of traditional telecommunication service going down, they already had to reshape their business models and right now, their focus is on mobile internet. In the Czech Republic, the mobile internet usage have been considerably lower in comparison to other European countries, which is something that the Czech mobile operators have been trying to change. This last year, they covered nearly the whole of Czech population with high quality and fast Long Term Evolution (LTE) mobile networks and at the moment, they are trying to teach their customers' to use them for mobile internet.

The research in this field follows the development. The consumers' behaviour is changing notably with new technologies, which also brings other implications for services in this sector. This study aims to examine consumers' Willingness To Pay for mobile internet in the Czech Republic and the factors influencing it, which has not been done specifically for the Czech market before. Consumer preferences are an important part of microeconomic consumer theory, which looks at the choices made by the consumers in order to maximize their utility. It is crucial not only for economists, but also for firms on the market, to understand what influences consumers' behaviour so they may react and adapt to it accordingly.

The structure of this thesis is as follows: in chapter 2, an overview of the ICT sector and the Czech telecommunication market is provided along with a summary of the literature on the relevant subjects. Chapter 3 explains the basic theoretical concepts that are dealt with throughout the thesis. Data description and empirical model are presented in chapter 4, the results are discussed in chapter 5. The last chapter summarizes the findings.

Chapter 2

Literature review

2.1 Overview of the ICT sector

2.1.1 Worldwide

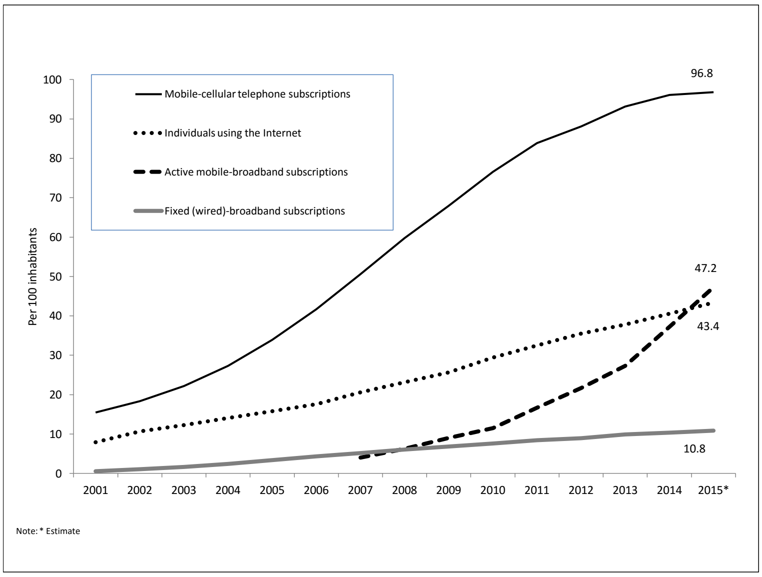
The ICT sector has been rapidly growing with new technologies causing not only industry changes in this sector but also in the economy as a whole. The global internet usage has jumped from 8% of the world's population in 2001 to over 43% in 2015 and the growth in the mobile sector has been even more rapid. Mobile-cellular telephone subscriptions increased from 15.5 subscriptions per 100 inhabitants to almost 97 in the last 15 years and active mobile-broadband subscriptions grew from 4 subscriptions per 100 inhabitants in 2007 to 47 in 2015 (ITU 2016). This development in the ICT sector is demonstrated in figure 2.1.

Mobile broadband is the prevailing method of accessing the internet worldwide, as the number of mobile broadband subscriptions is more than four times higher than fixed broadband subscriptions. This difference is even more sizeable in the developing world, where there are 5.5 times more mobile broadband subscriptions than fixed broadband (in the developed world it is only 3 times more). Figures 2.2 and 2.3 show the growth of fixed and mobile broadband subscriptions worldwide.

The biggest advantage of mobile internet over fixed broadband connection is that it enables access to the internet anytime and from any place. This has opened a lot of new possibilities for online services and business and changed the direction of the whole sector.

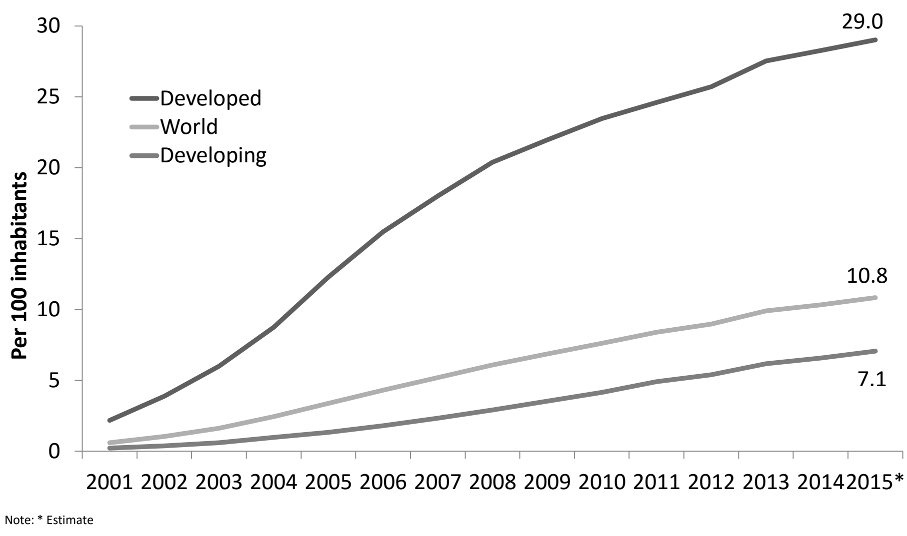
The first mobile data services became available in 1991 as a part of the Second Generation (2G) mobile phone technology. Since mobile phones be-

Figure 2.1: Global ICT developments, 2001-2015



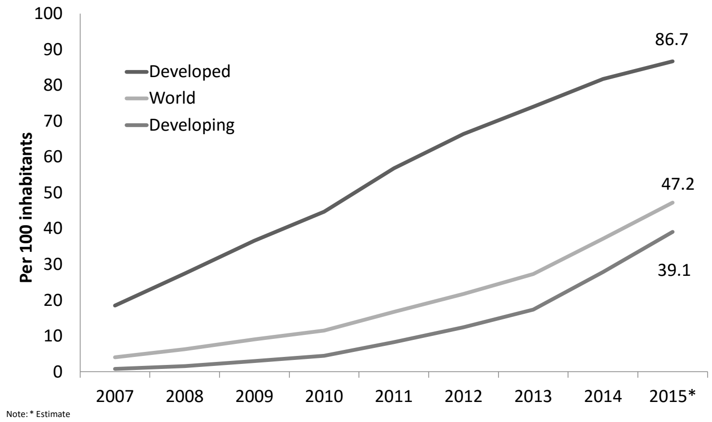
Source: ITU World Telecommunication /ICT Indicators database

Figure 2.2: Fixed broadband subscriptions, 2001-2015



Source: ITU World Telecommunication /ICT Indicators database

Figure 2.3: Active mobile broadband subscriptions, 2007-2015



Source: ITU World Telecommunication /ICT Indicators database

came a part of people's everyday lives, the demand for data has been growing rapidly. This lead to the transition from 2G mobile networks to Third Generation (3G), which started in early 2000s. However, not even the 3G has shown to be sufficient due to the increasing usage of data and therefore the industry is gradually switching over to Fourth Generation (4G) mobile networks since 2010. Each transition means higher download and upload speed, better quality of the connection, as well as higher data capacity.

2.1.2 Situation on the Czech telecommunication market

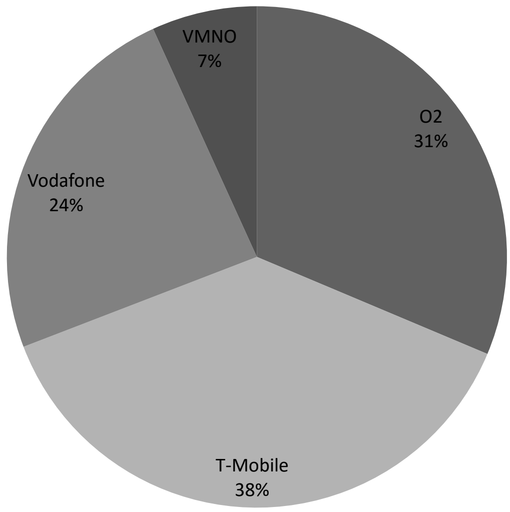
Out of all Czech inhabitants who are 16 years and older 97% uses a mobile phone, 74.4% uses a computer, 75.7% uses the internet and 37% uses mobile internet[1]. The number of active SIM cards in the Czech Republic has been stable for the past five years at just under 14 millions and almost half of them, approximately 6.6 million, are used for mobile internet (CTU 2016).

The Czech telecommunication market is dominated by three main providers: T-Mobile, Vodafone and O2. U:fon is a fourth provider, who uses slightly different technology. Then, there is a number of so-called virtual operators, which do not have their own infrastructure and thus use the infrastructure of other operators. The three main players altogether hold over 93% of the Czech market. The corresponding market shares[2] are shown in figure 2.4.

[1] Český statistický úřad, 2015

[2] The market shares are based on the number of active SIM cards of each operator.

Figure 2.4: Shares of MNOs (2015)



Source: CTU (2016)

The telecommunications market is naturally limited, because the frequency domain, which serves for passing the signal of mobile networks, has only a narrow bandwidth. The frequency domains in the Czech Republic are managed by the Czech Telecommunication Office (CTU), which assigns them to, among others, radio and television broadcasting, the army, security services, transport and also MNOs. If a new mobile operator would like to enter the market, it can buy a part of the frequency domain reserved for MNO. The CTU (which is state-owned) auctions off the frequency domain to MNOs to use for a certain time period, after which it will be offered again. So far, only the three main operators on the Czech market have secured parts of the domain for running a mobile network.

U:fon (which has been run by Air Telecom a.s. since 2012) entered the market in 2007 and in 2010 it was the first operator, that offered its infrastructure to Virtual Mobile Network Operators (VMNOs). For the virtual operators, it is much easier to join the market as they do not need their own infrastructure and only pay to the main MNOs to use theirs. The market of virtual operators is therefore quite dynamic, first big players emerged in 2013 and since then, tens of new virtual operators have been created, whilst others have perished.

In 2006 the CTU had recognized the Czech telecommunication market as sufficiently mature and competitive and therefore decided that there is no need for regulation (CTU 2015). However, the office reconsidered its decision after few years as it seemed that "the retail market was rather stagnating and the wholesale market had not developed accordingly to the expectations as other European markets had" seeing that no VMNO have entered the market by 2012 and nothing indicated any possible entrance (CTU 2015). In late 2011 the CTU defined new criteria for labeling the market as 'relevant' (in terms of regulation) based on recommendations from the European Commission. They specified the three following conditions:

1. present big and stable barriers to entry
2. structure of the market in a relevant time period is not heading towards effective competition
3. the rules of market competition are not sufficient on their own for dealing with failures of the imperfect market

In 2012 the CTU decided that the telecommunication market met all of these conditions and is therefore 'relevant' and it started to prepare detailed analysis (CTU 2015). However since then, fundamental changes in the sector have been made. First VMNOs entered the market in 2013 and simultaneously MNOs offered unlimited tariffs, arguably as a reaction to CTU in an attempt to avoid the regulation. Consequently, it was decided in 2015 that the market has managed to improve on its own and regulation is for that reason not necessary (CTU 2015). Nevertheless, this decision involves only the market of voice-calling and text-messaging services, i.e. it does not include the market with data services, which the office still sees as problematic.

To use mobile services, customers can choose between a pre-paid credit and a monthly subscription. Mobile broadband is usually offered in form of packages of internet data per month, these data can be offered on its own or in a bundle with other mobile services - free minutes and text messages. The three main providers keep more or less the same prices and services as they operate on an oligopolistic market. On the other hand, virtual operators bet on cheap internet connection or free calls within the same network. Generally, the prices in this sector have been decreasing steadily in the past few years. Especially the prices of mobile internet, that have been pushed down by the competition of VMNOs and prices of unlimited tariffs (unlimited calls and text messages) which have been pushed by competition between the three main MNOs.

2.2 Mobile internet

There are two types of technologies that enable to access the internet from personal devices. The first one is mobile broadband, which transfers data through mobile communications networks, usually provided by mobile phone operators. The second is fixed broadband, which works on the basis of Wireless LAN (WLAN) and it is marketed under the trademark Wi-Fi. These technologies can be seen as complements or substitutes, considering that most of the personal devices can access the internet using either of them. They differ mainly in the manner they are provided in.[3] Mobile broadband is vertically integrated, top-down technology with few big service-providers, whereas fixed broadband service is decentralized and end-user-centric. Lehr & McKnight (2003) compared 3G mobile technologies and Wi-Fi and provided predictions on the further development of wireless internet access. Their predictions were that neither of the technologies will dominate the market and that they will be complementary in the mass-market deployments, which have proved to be correct as nowadays most digital devices enable wireless access to the internet using both technologies and consumers can decide, which one their prefer. The last prediction was that Wi-Fi technology will be a competition for mobile broadband providers, due to the low-entry cost for creating a Wi-Fi network as opposed to the cost of infrastructure needed to provide mobile broadband service. This prediction was only partly correct, some end-user organized networks exist (provided by universities, cities, etc.), however these are not direct competition for mobile broadband providers, since the connection is limited to a certain area and consumers now demand ubiquitous internet coverage.

The following studies focus on the changes from the perspective of the telecommunications industry, namely on the addition of data transfer services to the traditionally offered voice communication and text messaging, which came with the transfer from 2G to 3G technology. Makki *et al.* (2003) describe the challenges from the mobility perspective that needed to be overcome for a true wireless internet service solution, such as maintaining stable and high-quality connection whilst moving among different locations. Tilson & Lyytinen (2006) look at specific characteristics of the industry, i.e. coordination and technical standards, which are crucial for its development. They discuss the standardization that is needed for proper cooperation between different types of

[3] Historically, mobile broadband offered lower speed, but as the technology enhances, the attributes of the two technologies are converging.

firms, such as manufacturers of mobile devices, service providers and software developers, to extract value of the new technologies. The cooperation is needed throughout the whole process, which starts with an innovation and ideally ends at the marketplace, under the supervision of governmental regulatory bodies.

2.3 Consumer preference & WTP

Willingness to Accept and Willingness To Pay are two related concepts, that fall under microeconomic consumer theory, which studies the process of consumers' utility optimization. Willingness to Accept (WTA) is the minimum amount of money for which a person is willing to give up a good or endure something negative. Conversely, WTP is the maximum amount of money a person is willing to pay for a good or a service and it matches the reservation price. The price of every transaction is thus always somewhere between the seller's WTA and buyer's WTP (Horowitz & McConnell 2003). Hanemann (1991) studies the difference between WTP and WTA considering welfare changes (due to e.g. changes in availability of a public good). The welfare change can have either compensating or equivalent variation, which corresponds to the WTA and WTP respectively. He showed that despite the theoretical assumption of close equality between the two concepts, their values can differ notably, as they depend on the substitution effect.

The knowledge of consumers' WTP is very beneficial for a company, as it enables the company to set the optimal pricing strategy for their products. However, most of them still use the so called 'intuitive' pricing, rather than pricing strategies based on likely buyer's response behaviour (Breidert *et al.* 2006). Valid WTP estimates are important for developing the optimal pricing strategy. By understanding the customers, a firm can improve its position, as it has been shown, that satisfied customers are willing to pay more (Homburg *et al.* 2005).

Breidert *et al.* (2006) provide an overview of the literature on different approaches to the measurement of WTP. The measurements of WTP are classified into two groups: stated preferences and revealed preferences. Stated preferences are obtained from direct and indirect surveys and revealed preferences from market data and experiments. Market data are generally very reliable as they represent real purchase behaviour, however they are available only for products already on the market and do not allow for price variation. Experiments allow observing real purchase behaviour with varying products and prices, but are very costly and time demanding. Therefore, surveys are in general the most appropriate method for examining WTP, due to their flexibility. Nevertheless, the estimates of WTP from a direct survey have lower validity, because the real purchase behaviour is not observed and there is a number of possible biases (stating WTP for an unfamiliar product, overestimation due to prestige effect, etc.). The biases can be reduced by using indirect survey and estimating the WTP by statistical techniques.

An online questionnaire is an appropriate method for collecting data about consumer preferences, especially for studies on topics from online environment. The data are relevant as the respondents are regular users of the internet, who are active online. It is also very time and cost effective and for these reasons, it is often the method of choice (Vala 2015).

The telecommunication industry has a specific cost structure with high initial fixed cost and very low or even zero marginal cost. This means, that the prices cannot be determined by the marginal costs as they are, from microeconomic theory, in other industries and therefore the pricing is predominantly based on customers' WTP. Consumers' preferences and their WTP for telecommunications services are being studied extensively and because this industry sector is extremely dynamic, the WTP is constantly evolving with the adoption of new technologies and the expansion of available services. The next section presents an overview of the literature on consumers' WTP in the telecommunications industry with focus on the mobile internet.

2.3.1 WTP for mobile internet studies

Most of the research on consumer preferences in mobile telecom services is done using stated preferences in the form of conjoint analysis or a choice experiment (e.g. Kim (2005), Shin *et al.* (2011), Kwak & Yoo (2012)). Selected attributes of the service are examined to determine the value assigned to them by the consumers. Some examples of this kind of studies are provided in the following part of this thesis.

Technology generation transitions

Kim (2005) considers consumer preferences in telecommunication services with 3G technology with the following attributes: price, video telephony, global roaming and multimedia mobile internet applications. The results show a large variation in consumers' preferences. Generally, consumers placed the highest value on the video telephony service, however there is a considerable difference among population in preferences for global roaming and multimedia mobile Internet, as part of the population has no interest in these attributes, while others place high value on them. The distribution of WTP is highly skewed to zero and there are also big differences between the mean and the median of individuals' WTP. These findings suggest the need for targeted marketing by identifying groups of consumers with similar taste.

Shin *et al.* (2011) include mobile number portability service, call and service quality, company's brand and offered discounts. The option to keep the same mobile number, when changing the service provider, creates more competitive market, which brings benefits to the consumers such as lower price, higher quality, greater choice and greater range of services. Simultaneously, it significantly decreases the switching costs for customers and reallocates the property rights of a mobile telephone number from operators to customers. The survey was conducted in a developing mobile telecommunication market in Uzbekistan. The most important attribute for consumers was the price, followed by call and service quality. Company's brand was the third most valued attribute, offered discounts the fourth. The lowest importance score was given to the mobile number portability service, which creates welfare by increasing the competition on the market, but is not valued by the consumers directly on its own.

Kwak & Yoo (2012) look at the transition from 3G to 4G services including data rates, communications service, number of broadcasting channels, video-on-demand and other supplementary services as the attributes. The results show that the quality of communications services is viewed as the most important by the consumers. The respondents were not interested in data transmission speed, which implies, that they still consider traditional mobile services (calls and text messaging) to be the most important and do not place high value on mobile internet.

Dagli & Jenkins (2016) use choice experiment to evaluate consumers' preferences for improvements in mobile telecom services from the introduction of 4G technology, namely increased mobile internet speed, unlimited mobile internet use, improved quality of communications services and unrestrained use abroad.The survey was conducted in North Cyprus, where many people often travel to Turkey and South Cyprus and therefore the unrestrained use abroad showed the highest marginal WTP, followed by increased internet speed and unlimited use. Improved quality was insignificant, which suggests that consumers are satisfied with the current quality and do not require any improvements.

Bundled services

Mobile operators usually provide their services in bundled packages under one price. The bundles consist of minute packages, text messages and internet data, long-term contracts often include a subsidized mobile phone. The WTP for the bundle than depends on the importance of each attribute for the consumer, which can be measured using the conjoint analysis as done by Klein & Jakopin (2014). Their results show highest relative importance of the price, followed by minutes included, internet access and text messaging. Subsidized cellular phone included in the bundle with a long-term contract has also higher relative importance than text messaging, but lower than minutes included and internet access.

3G vs WiFi

Content-based pricing is dominant in the mobile telecommunications industry. That means that customers are charged per minutes spent calling, texts sent and data used and therefore they see paying for services as a natural thing. On the other hand, internet users are now used to free services in the fixed internet (after paying for the connection). This creates a big difference in the paying scheme of the two competing technologies, 3G and WiFi, and puts consumers in front of a decision, how they want to use and pay for mobile internet. Many households already have fixed internet connections, which they can use to access internet from their mobile devices as well. Next to it, there are more and more public hotspots, providing free Wi-Fi connection in places like restaurants, coffee shops, shopping malls, libraries, schools, airports, train stations, public transport, etc. This possibly decreases the WTP of consumers, as they can access the internet for free instead of paying based on the services used. Consumers therefore face the trade-off between free connection and availability and quality of the connection. Kivisaari & Luukkainen (2003) look at these differences in terms of pricing and possible future development. They conclude that mobile services have advantages over the fixed internet, namely that they can utilize the current time and location of the user, which suggests a possibility for creating a new environment, where the content-based pricing would be prevailing. Service differentiation based on timeliness, personalization and location information has crucial role in creating a profitable content services.

The price setting in this environment is very flexible and can be customized based on individuals' WTP, which could result in price discrimination.

2.3.2 Technology adoption model

Another way of studying the use of mobile internet is to look at what influences the consumers' decision to start or not to start using the mobile internet as a technology. The Technology Acceptance Model (TAM) has been used to study consumers' use and acceptance of new technologies. The most widely used model was developed by Davis Jr (1986), who divides the factors influencing consumer motivation into *perceived usefulness* and *perceived ease of use*, these combined form the attitude towards using and from that follows the actual use of the technology. Davis Jr (1986) defines *perceived usefulness* as "the degree to which an individual believes that using a particular system would enhance his or her job performance" and *perceived ease of use*, which has a causal effect on the perceived usefulness as "the degree to which an individual believes that using a particular system would be free of physical or mental effort." Traditionally, the TAM is used in the workplace environment to describe the adoption of technology as a part of work performance, if we use it in a consumer context, the attitude towards using is determined by a hedonic factors (like fun and enjoyment from the usage) as well as the utilitarian motivations (Childers *et al.* 2001). The model is than called consumer TAM (c-TAM) and it is often used in studies concerning consumers' online shopping behaviour and their online purchase intentions (e.g. Cho & Sagynov (2015), Childers *et al.* (2001)).

c-TAM based studies of mobile internet adoption

Amongst the researchers, who use the c-TAM to explain consumer behaviour regarding mobile internet, we can name Bruner II & Kumar (2005) who examine consumers' acceptance of handheld internet devices. They found that the ease of use notably affects the perceived usefulness, as well as the fun aspect and that in the consumer context, the fun aspect shows to be more important than the usefulness. Another example is Kim *et al.* (2007), whose focus is on value-based adoption of mobile internet and they conclude that the perceived value is significantly related to the adoption intention. The authors divided perceived value into two components: benefit component (perceived usefulness and enjoyment) and sacrifice component (technicality and perceived fee). The results support the hypothesis, that benefit components are positively correlated with perceived value and sacrifice components are negatively correlated with perceived value. As expected, the sacrifice components have larger impact on perceived value than benefit components, as customers are "deterred more by costs than they are attracted by benefits." Yang & Lee (2010) use the TAM to study potential differences in the motivation for using mobile internet between genders. Their findings suggest that men are more influenced by the utilitarian aspects and therefore prefer task-oriented services, whereas women seek hedonic aspects, i.e. personal and communication-oriented services.

Chapter 3

Theoretical concepts

3.1 Adoption (paying) intent

The study of consumer behaviour is one of the main areas of focus of microeconomics, as it is very important not only for economists, but also for firms to understand how consumers make their decisions and what influences it, in order to optimize their products or services to maximize the profit.

Adoption or paying intent is a variable used to denote the decision of a consumer, whether to adapt a technology or pay for a good or a service or not. In this thesis the adoption intent therefore represents consumers' WTP for mobile internet. We can consider both ways in which this variable is used, adoption intent, which deals mainly with adoption of new technologies among consumers and here accordingly symbolizes the decision of consumers to start using mobile internet as a technology, and paying intent symbolizing accordingly the readiness to pay for such a technology. Adoption intent is the final step of the TAM derived from the individuals' motivation.

3.2 Binary response model estimation

In the analysis, we use the adoption intent as a limited dependent variable which can only obtain two values: 0, for not using the technology and 1 for using the technology. This type of variable is called a binary variable and it can be estimated by *binary response models*. A binary response model estimates the *response probability*

$$P(y = 1|\mathbf{x}) = P(y = 1|x_1, x_2, \ldots, x_n),$$

where $\mathbf{x}$ denotes the full set of explanatory variables[1]. We put

$$P(y = 1|\mathbf{x}) = G(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k) = G(\beta_0 + \mathbf{x}\boldsymbol{\beta}),$$

where G is a function with values strictly between 0 and 1, that is $0 < G(z) < 1$ for all $z \in \mathbb{R}$, and $\mathbf{x}\boldsymbol{\beta} = \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k$. This ensures that the response probability will be strictly between zero and one, which conforms to the definition of probability, as opposed to the classic Linear Probability Model (LPM), which has its limitations when dealing with limited and more specifically binary variables. The two most frequently used G functions, that take on values between zero and one and are therefore suitable for the binary response model estimations, are the logistic function

$$G(z) = \frac{\exp(z)}{[1 + \exp(z)]} = \Lambda(z), \tag{3.1}$$

and the standard normal Cumulative Distribution Function (cdf)

$$G(z) = \Phi(z) = \int_{-\infty}^{z} \phi(\nu) d\nu, \tag{3.2}$$

where $\phi(z)$ is the standard normal density

$$\phi(z) = \frac{1}{\sqrt{2\pi}} \exp(-z^2/2). \tag{3.3}$$

Both of these G functions have a similar shape. They are increasing, both of them the most quickly when $z = 0$. For $z \to -\infty$ we have $G \to 0$ and $G \to 1$ as $z \to \infty$. The functions are plotted in figure 3.1.

When we use the logistic function, the model is called logit model, and with the standard cdf the model is called probit model. These models are derived from and underlying *latent variable model*, where y^* is an unobserved (latent) variable, determined by

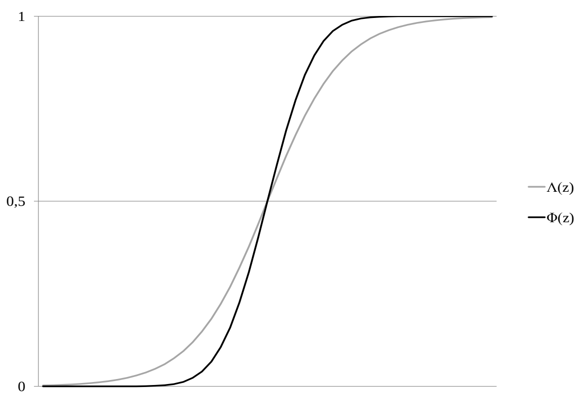
$$y^* = \beta_0 + \mathbf{x}\boldsymbol{\beta} + e, \quad y = 1[y^* > 0].$$

The function $1 = [\cdot]$ is an *indicator function*, which takes value one, if the event in the bracket is true and zero otherwise. Therefore we have

$$y = \begin{cases} 1 & \text{if } y^* > 0, \\ 0 & \text{if } y^* \leq 0. \end{cases}$$

[1]The notation used here is taken from Wooldridge (2008)

Figure 3.1: Comparison of standard normal cdf and logistic function



Source: author's computations.

We assume that e is independent of $\mathbf{x}$ and has either the standard normal distribution (in the probit model) or the logistic distribution (in the logit model) with zero mean. The probit model is sometimes preferred in econometrics due to the normality assumption for e. The response probability for y is then derived as follows:

$$P(y=1|\mathbf{x}) = P(y^* > 0|\mathbf{x}) = P[e > -(\beta_0 + \mathbf{x}\boldsymbol{\beta})|\mathbf{x}]$$
$$= 1 - G[-(\beta_0 + \mathbf{x}\boldsymbol{\beta})] = G(\beta_0 + \mathbf{x}\boldsymbol{\beta}). \quad (3.4)$$

In the binary response model we want to estimate the effect of the explanatory variables x_j on the response probability $P(y=1|\mathbf{x})$. As opposed to the standard LPM, the β coefficients do not have a straightforward interpretation, due to the non-linear nature of function $G(\cdot)$. However, we can use calculus, to estimate the partial effects of each explanatory continuous variable, which are obtained from the derivative:

$$\frac{\partial P(y=1|\mathbf{x})}{\partial x_j} = \frac{dG}{dx_j}(\beta_0 + \mathbf{x}\boldsymbol{\beta})\beta_j = g(\beta_0 + \mathbf{x}\boldsymbol{\beta})\beta_j. \quad (3.5)$$

The partial effect will always have the same sign as β_j, because $G(\cdot)$ is a strictly increasing function. Therefore we can easily determine whether the given explanatory variable has a positive or a negative effect, nevertheless estimating the magnitude of the effect is more complicated.

For binary variables, the computation of the partial effect is very straightforward. If, for example, x_1 is a binary variable, the partial effect of changing the value of x_1 from 0 to 1, holding all other variables fixed, is equal to:

$$G(\beta_0 + \beta_1 + \beta_2 x_2 + \ldots + \beta_k x_k) - G(\beta_0 + \beta_2 x_2 + \ldots + \beta_k x_k). \tag{3.6}$$

This difference can also be used for other types of discrete variables. We simply multiply the corresponding beta coefficients by the two values of the discrete variable between which, we want to calculate the difference.

To estimate the non-linear binary response models, we use the method of Maximum Likelihood Estimators (MLEs). Under general conditions, the MLEs are consistent, asymptotically normal and asymptotically efficient. With standard errors of $\hat{\beta}_j$, which are given by most statistical softwares in the results of logit regression, we can construct confidence intervals and t tests to test our hypotheses in the same way as with the standard Ordinary Least Squares (OLS) regression.

We cannot measure the goodness-of-fit of a binary model by the R^2 statistic as with the OLS regression, because the estimates are not calculated to minimize the variance, but they are maximum likelihood estimates, arrived at through an iterative process. However, several pseudo R^2s have been developed to measure the fit of the model. They obtain the same values as normal R^2, on a scale from 0 to 1, and the higher the value, the better the fit of the model. In this thesis, McFadden's R^2 is provided with the regression results, which is calculated as

$$R^2 = 1 - \frac{ln[\hat{L}(M_{full})]}{ln[\hat{L}(M_{intercept})]},$$

where M_{full} is the full model with predictors and $M_{intercept}$ is model only with the intercept. $\hat{L}$ stands for the estimated likelihood. Higher R^2 means higher likelihood of the model.

As the magnitude of the partial effects in 3.5 and 3.6 depends on $\mathbf{x}$ (i.e. on values of all explanatory variables), it is hard to summarize them. We can plug in interesting values for each x_j, such as means, medians, upper and lower quartiles, minimums, and maximums, but this will not always bring much information and it can be quite tedious. There are two approaches to reporting the partial effects. One method is to replace each explanatory variable with its sample average, we then have the partial effect of x_j equal to

$$g(\hat{\beta}_0 + \bar{\mathbf{x}}\hat{\boldsymbol{\beta}})\hat{\beta}_j = g(\hat{\beta}_0 + \hat{\beta}_1 \bar{x}_1 + \ldots + \hat{\beta}_k \bar{x}_k)\hat{\beta}_j, \tag{3.7}$$

where $g(z) = exp(z)/[1 + exp(z)]^2$ for the logit model. This approach provides the partial effect of the x_j for the 'average' person in the sample and it is called the Partial Effect at the Average. The second method averages the individual partial effects across the sample, leading to the Average Partial Effect. The resulting partial effects of these two approaches can be quite different as one uses the average of the nonlinear function and the other one the nonlinear function of the average. They can be computed by most econometrics software packages. The PEAs are more suitable, when it makes sense to interpret the effects for the 'average' person. However, if we have two different groups in the sample, the 'average' does not need to represent any actual observations and therefore in this case, the APEs are better (this applies, e.g. if we have a lot of binary explanatory variables).

Chapter 4

Data and Empirical Model

4.1 Data collection

The data for this thesis were collected via a self-developed online questionnaire, which was distributed through social media, online forums and e-mails. The questionnaire was made in Czech language, because the focus of this thesis is on the Czech market. It took approximately five minutes to complete, in total 238 responses were collected. The full questionnaire is enclosed in appendix A, along with English translation for each question. The questionnaire was made online via Google Forms and the responses were collected during June 2016. Thanks to this approach, we had individual responses available in full and we were able to verify them. All of the questions were compulsory, so none of the data were incomplete.

4.2 Variables & Hypotheses

This section provides an overview of the variables included in the model. Furthermore, several hypotheses, which are to be tested by the model, are stated based on the previous literature summary provided in chapter 2.

Dependent variables

As the dependent variable in the primary logit model, we use the *adoption intent* which was already discussed in section 3.1. It is a binary variable with value 1, representing the respondents who use mobile internet and 0, representing those, who do not.

In the additional model, the dependent variable is *Price*, which the respondents would be willing to pay for their optimal tariff. It is a continuous variable, hence a simple OLS regression can be used to estimate it. This model is described by equation 5.2.

Independent variables

To start with, we have two sets of binary variables. First set is for determining what digital devices the respondent owns. The set includes the following variables: *Smartphone*, *MobilePhone*, *Laptop*, *Tablet* and *PC*. The second set indicates services of which mobile operator the respondent uses. This set includes: *T-Mobile*, *O2*, *Vodafone* and *Virtual*. Each of these variables obtain value 1, if the respondent owns the device or uses the MNO and 0 otherwise. These variables are coded as binary, rather than as categorical, because each respondent can own multiple devices or use the services of multiple providers. The following hypotheses are stated about these variables:

Hypothesis 1.a Ownership of a smartphone has a positive effect on the WTP for mobile internet. (As it is the most convenient device for using mobile internet.)

Hypothesis 1.b Ownership of a tablet has a positive effect on the WTP for mobile internet. (Because having mobile internet in a tablet enables to use its full potential.)

Hypothesis 1.c Ownership of a classical mobile phone has a negative effect on the WTP. (As it is not very practical for connecting to the internet.)

Hypothesis 2 There is a significant relationship between using the services of a VMNO and the WTP for mobile internet. (Because virtual MNOs generally offer cheaper internet data.)

Next we have three continuous variables. *MonthlyPayment* specifies the amount paid for mobile services per month in CZK. *WorkHours* and *FreeHours* measures the time spent online either at work and school or as a part of free time. We also included the total number of hours spent online as *HoursOnline*. The separation is because the online behaviour at work supposedly differs from free time and the amount of time on the internet at work is not directly decided by the respondents.

Hypothesis 3 Hours spent online have a positive influence on the WTP. (Someone who spends a lot of time on the internet will supposedly want to have the connection always available.)

WorkWifi is a binary variable with value 1 if the respondent has free Wi-Fi connection available at work or at school for students. The availability of free Wi-Fi connection arguably has an influence on the WTP for mobile broadband.

Hypothesis 4 Having available Wi-Fi connection at work or school has a negative influence on the WTP. (If the respondent has free connection available, where he spends a lot of his time, he does not need to pay for mobile internet.)

The following variable measure the preferences about the internet connection on a likerts scale, with range from 1 to 4. *Speed* denotes the importance of speed of the connection, *Availability* measures the importance of having the connection always available (1 meaning not important and 4 very important). *FreeWifi* denotes if the respondents often use free Wi-Fi connection at public hotspots.

Hypothesis 5.a Consumers' perceived importance of the speed of the connection has a positive influence on their WTP. (The cheaper packages of mobile internet data are usually associated with slower connection after using a certain amount of data.)

Hypothesis 5.b Consumers' perceived importance of the availability of the connection has a positive influence on their WTP. (Ubiquitous availability is one of the biggest advantages of mobile broadband.)

Hypothesis 5.c Frequent use of public Wi-Fi hotspots has a negative influence on the WTP. (If someone uses mobile internet, they do not need to connect to public hotspots.)

Tariff is coded as a categorical variable which denotes if and what type of mobile tariff the respondent uses. It obtains value 0 for 'no tariff', 1 for 'company tariff', 2 for 'family tariff', 3 for 'unlimited tariff' and 4 for 'other tariffs'. *Access* is also a categorical variable with values from 1 to 4 to differentiate how the respondents access the internet the most often. It has value 1 for connection from PC or laptot via Wi-Fi, 2 from PC/laptot via network cable, 3 for connection from smartphone or laptop via Wi-Fi and 4 for connection from smartphone/tablet via mobile broadband. Category 4 of *Access* predicts success perfectly (i.e. all respondents, who connect to internet most often from smartphone/tablet via mobile broadband, naturally use mobile broadband) and for that reason, this variable could not be used for the estimation. Therefore we defined a new variable *Access2*, coded as a binary variable with value 0 for connection from PC/laptop and value 1 for connection from smartphone/tablet.

Hypothesis 6 Having a monthly tariff is positively correlated with the WTP. (Mobile internet is favourably offered in form of mobile tariffs.)

Hypothesis 7 Using a smartphone or a tablet to access the internet has a positive effect on the WTP. (Because you can carry them around and therefore being able to browse the internet from different places would be optimal.)

We used three variables to learn about how the respondents use the mobile internet. Firstly, a categorical variable *Apps* with values from 0 to 4, which describes how the respondents use mobile applications requiring access to internet. The values are assigned as follows: 0 for 'never', 1 for 'only e-mail', 2 for 'rarely', 3 for 'only with Wi-Fi connection' and 4 for 'regularly, everyday'. Secondly, variable *ChatApp* denotes how many application for online messaging and calls or video calls through internet the respondent uses. And thirdly, variable *Socialmedia* denotes how many social media applications the respondents use.

Hypothesis 8 Using mobile applications positively affects the WTP. (Mobile internet is required to fully take advantages of the mobile applications.)

The respondents, who answered 'yes' for the question if they use mobile broadband connection, were asked about how much data they use per month and how much they pay for mobile internet monthly. These answers are coded as continuous variables *MBmonthly* and *internetpayment* respectively.

Finally, we have variables describing the demographic data of the sample.

Age is a continuous variable, *Female* is a binary variable with value one if the respondent is female and zero for male. *Education* is a categorical variable with values matched to the number of years spent at school (9 for 'elementary education', 15 for 'high school education' and 18 for 'university education', which corresponds to the time each level of education lasts in the Czech Republic). *Occupation* is another categorical variable with values from 1 to 4 (1 for 'student', 2 for 'employed', 3 for 'self-employed' and 4 for 'unemployed'). Due to the fact, that category 4 of the variable *Occupation* (standing for 'unemployed') included only one observation, for which the failure was predicted perfectly, this observation had to be excluded from the estimation. *Income* is also a categorical variable which divides the sample into four categories according to the monthly income of the respondents (category 1: 0 – 10 000 CZK, category 2: 10 001 – 20 000 CZK, category 3: 20 001 – 30 000 CZK and category 4: 30 001 CZK and more).

4.3 Empirical model

The empirical model used for the estimation is expressed by equation 4.1, where $G(\cdot)$ stands for the logistic function $G(z) = \Lambda(z) = \exp(z)/[1 + \exp(z)]$.

$$\begin{aligned} P(Intent = 1|\mathbf{x}) = G(&\beta_0 + \beta_1 Age + \beta_2 Female + \boldsymbol{\beta_3} Education \\ &+ \boldsymbol{\beta_4} Occupation + \boldsymbol{\beta_5} Income + \beta_6 Smartphone \\ &+ \beta_7 MobilePhone + \beta_8 Tablet + \beta_9 Laptop + \beta_{10} PC + \beta_{11} T\text{-}Mobile \\ &+ \beta_{12} O2 + \beta_{13} Vodafone + \beta_{14} Virtual + \beta_{15} HoursOnline \\ &+ \beta_{16} WorkWifi + \beta_{17} Speed + \beta_{18} Availability + \beta_{19} FreeWifi \\ &+ \boldsymbol{\beta_{20}} Tariff + \beta_{21} SocialMedia + \beta_{22} ChatApp + \boldsymbol{\beta_{23}} Apps + \beta_{24} Access2) \end{aligned} \tag{4.1}$$

The effects of the independent variables on *Intent* are examined. The model was evaluated using *Stata 11.0* software, the results are presented in section 5.1. Note that bold coefficients are used for categorical variables. They represent the corresponding set of dummy variables (one for each category), which is created by the statistical software.

4.4 Descriptive statistics

The total sample consists of 238 responses collected by the online questionnaire. The demographic characteristics of the sample are presented in table 4.1. Almost 52 percent of the respondents were male and just over 48 percent female. The average age was a little over 27 years, with the majority of respondents being between 14 to 25 years old, accounting for nearly 61 percent of the sample. 5 percent of the respondents have completed only elementary education, 50 percent high school education and 45 percent university education. The majority, that is 55 percent, were students, 30 percent employed and 14 percent self-employed, 1 respondent was unemployed. The range of income of the respondents corresponds to the occupation with 47 percent having monthly income of 0 – 10 000 CZK, 25 percent 10 001 – 20 000 CZK, 12 percent 20 001 – 30 000 CZK and just under 16 percent with monthly income of more than 30 000 CZK. The sample is slightly skewed, in regards to age, education, occupation and income, due to the fact that responses were collected mainly amongst author's peers, i.e. university students or graduates.

The most common electronic device was a laptot computer, owned by 85 percent of the respondents. 80 percent owned a smartphone, 27.3 percent tablet. Some people use the service of multiple mobile operators, as they own multiple mobile phones, and some phones enable to use two SIM cards of different operators simultaneously. Most popular operator in the sample was O2, with 39.5 percent of the respondents using its services, in the second place was T-Mobile with 36 percent, Vodafone is used by almost a quarter of the sample, i.e. 24.4 percent. Only 10 percents of the respondents uses mobile services by a virtual operator, either on its own or in combination with one of the classic MNOs. Table 4.2 shows the share of the operators in the sample. 77.3 percent of the respondents have some sort of a tariff, within that 18 percent have unlimited tariffs. The rest use pre-paid credit. On average, the respondents spend a little over 373 CZK on mobile services per month.

On average, the respondents spend nearly 8 hours online per day, 4.5 hours as part of their job or school requirements and 3.4 hours in their freetime. Around half of the respondents access the internet most often from their laptop or PC through Wi-Fi connection and almost a third of them through cable connection. 15 percent of the respondents mainly access the internet using mobile phones or tablets, 10 percent via Wi-Fi connection and 5 percent by means of mobile data. 88 percent of the respondents have available Wi-Fi

Table 4.1: Sample description

Variable	Frequency	Percentage
Gender		
male	123	51.68
female	115	48.32
Age		
14 – 25	145	60.92
26 – 35	61	25.63
36 – 50	24	10.08
51+	8	3.36
Education		
elementary	13	5.46
high school	118	49.58
university	107	44.96
Occupation		
student	132	55.46
employed	71	29.83
self-employed	34	14.29
unemployed	1	0.42
Income		
0 – 10 000	123	47.48
10 001 – 20 000	60	25.21
20 001 – 30 000	28	11.76
30 001+	37	15.55
n	238	

Table 4.2: Shares of MNOs in the sample

MNO	Frequency	Percentage
O2	94	39.5
T-Mobile	86	36.1
Vodafone	58	24.4
virtual operators	24	10.1

connection at their work or school.

Over half of the respondents regularly use mobile applications, which require internet access. Another 20 percent use them, but only with Wi-Fi connection. 17 percent do not use them at all. 82 percent of the respondents use applications enabling communication via internet (either messaging, voice calls or video chats), about a quarter of the respondents use more than one. The most popular being Facebook Messenger, which is used by 59 percent of the respondents, and Skype, used by 48 percent. Almost 68 percent of the respondents use social media applications on their mobile phones, again about a quarter of the respondents have more than one social media application on their phone. The most popular social network is Facebook, with two thirds of the sample using it, other social media are far behind, Instagram and Twitter are used by less than 15 percent of the respondents.

To learn about respondents' preferences regarding characteristics and the way of using internet connection, we used the likert scale and asked the respondents to evaluate if they agree with the following statements on a scale of one to four, with one meaning '*strongly disagree*' and four '*strongly agree*':

- *"The speed of the connection is important to me."*
- *"I want the connection to be available at all times."*
- *"I often use free Wi-Fi connection at public hotspots."*

A large part of the respondents assessed the speed of the connection as important, specifically 73 percent. The availability was seen as less important, with only 55 percent of the respondents identifying with the statement, that they want the connection to be always available. And only 30 percent of the respondents regularly use free Wi-Fi connection at public hotspots.

Out of the 238 respondents, 64 percent use mobile broadband to access the internet. The average monthly amount of data used is over 1.1 GB and average monthly payment 210 CZK.

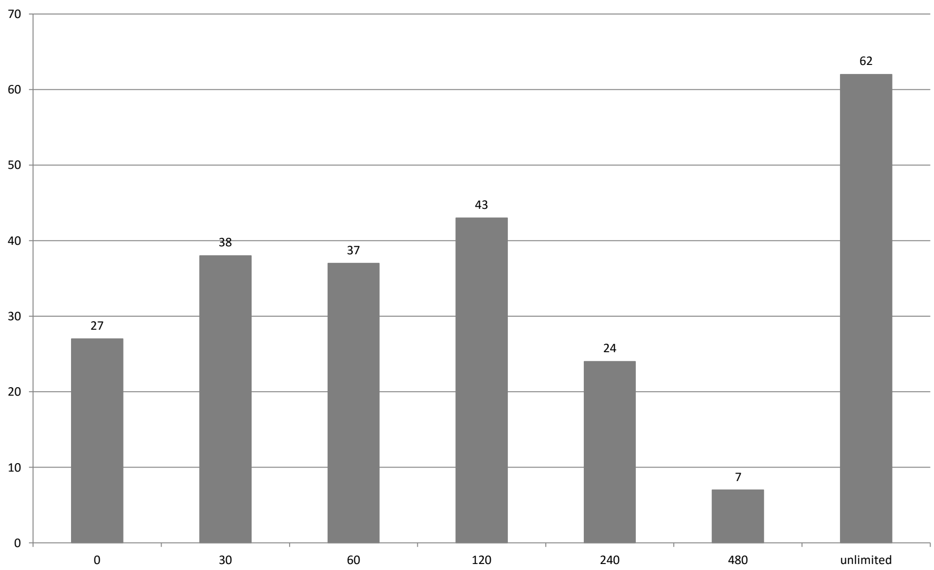
4.4.1 Configuration of optimal tariff

As a part of the questionnaire, we let the respondents to set their ideal tariff, by way of determining how many free minutes for calls, text messages and internet data would the respondents have in their optimal bundle of mobile services. And then we asked them what price they would be willing to pay for such a bundle. This way, we also got respondents' stated preferences, which we can compare with revealed preferences that we get from the survey.

The decision to include this part into the questionnaire was motivated by previous studies, that use choice experiment to determine consumers' WTP (e.g. Dagli & Jenkins (2016), Kwak & Yoo (2012)). In a choice experiment, the respondents are given several options of mobile service bundles, which differ in their attributes, and they have to select to most preferred one. For studying the preferences in mobile services, the attributes can include increased mobile internet speed, unlimited mobile internet use, improved quality of communications services and unrestrained use abroad (Dagli & Jenkins 2016) or data rates, communications service, channels, video-on-demand service and other supplementary services (Kwak & Yoo 2012).

The responses are summarized in figures 4.1, 4.2 and 4.3. 26 percent of the respondents would like to have unlimited calls, 22 percent unlimited text messages and 19 percent unlimited internet data. Out of those, who did not marked unlimited, the average amount of free minutes was 100, 86 text messages and just a little over 1 GB of internet data.

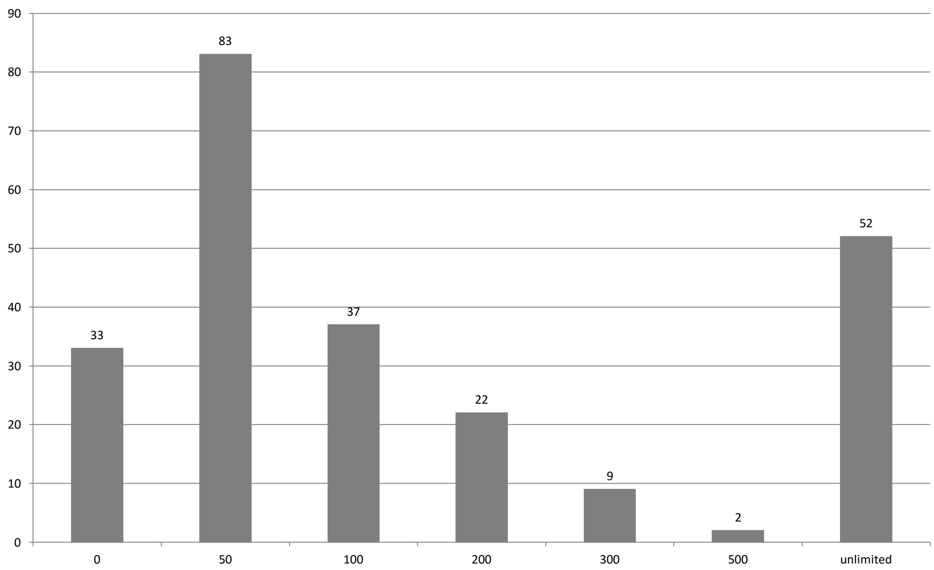
Figure 4.1: Free minutes



Source: author's computation based on online questionnaire about optimal tariff

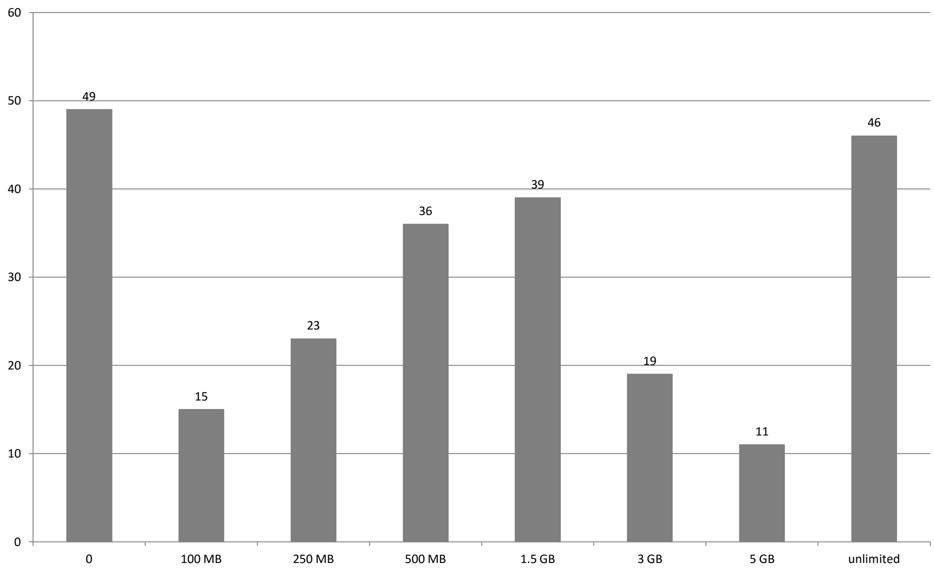
The average price that the respondents would be willing to pay for their optimal tariff was just over 360 CZK. It corresponds to the price they are paying for mobile services at the moment, which would suggest that they are satisfied with the prices in the telecommunication sector. The median is the same for

Figure 4.2: Text messages



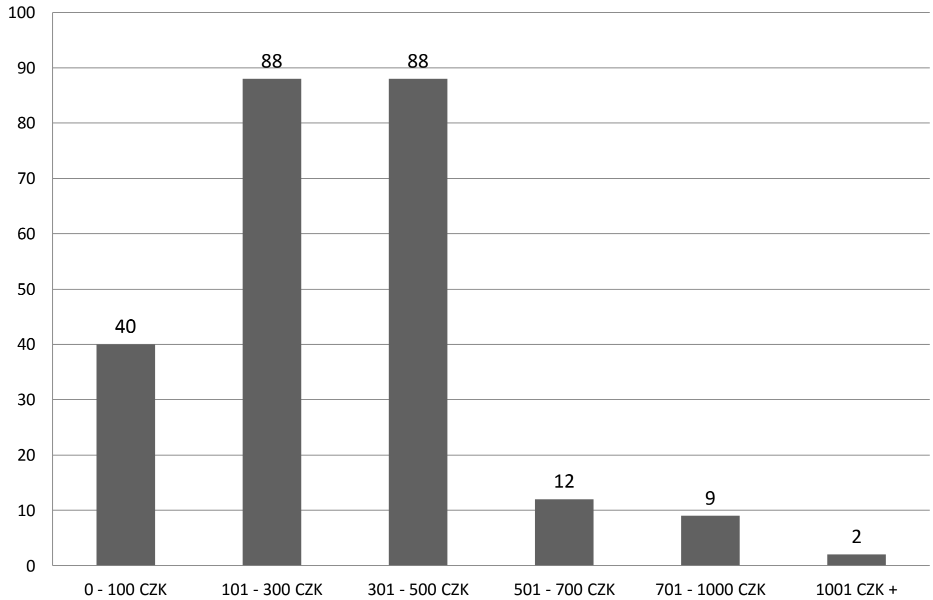
Source: author's computation based on online questionnaire about optimal tariff

Figure 4.3: Internet data



Source: author's computation based on online questionnaire about optimal tariff both values (i.e. actual and potential monthly payment) 300 CZK. Figure 4.4 shows the distribution of the price.

Figure 4.4: Price



Source: author's computation based on online questionnaire about optimal tariff

Chapter 5

Results

5.1 Logit regression results

For the estimation, the author of this thesis has decided to use the logistic regression, the reasons behind that decision have already been explained in section 3.2. To select the variables that have a significant influence on the dependent variable *Intent*, several models have been tested and compared using the *LR test*. The test compares the likelihoods of unrestricted and restricted model and it is similar to the F test. The LR statistic, which is computed as twice the difference between the log-likelihoods of the two models: $LR = 2(\hat{L}_{ur} - \hat{L}_r)$, follows the chi-square distribution with degrees of freedom equal to the number of variables excluded in the restricted model. The results of the LR tests are shown in appendix B. Some of the tested models are presented in table 5.1.

Based on the results of the LR tests, model (2) was selected as the best fitted one. The final model is than expressed by equation 5.1. Binary variables indicating digital devices (other than smartphones) and mobile operators were not included, as they proved not to improve the model, as well as variables *Hoursonline*, *Workwifi*, *Access2*, *Speed*, *Freewifi*, *Socialmedia*, *Chatapp*. The function $G(\cdot)$ indicates the logistic function $G(z) = \Lambda(z) = \exp(z)/[1 + \exp(z)]$.

$$\begin{aligned} P(Intent = 1|\mathbf{x}) = G(&\beta_0 + \beta_1 Age + \beta_2 Female + \beta_3 Education \\ &+ \boldsymbol{\beta_4} Occupation + \boldsymbol{\beta_5} Income + \beta_6 Smartphone \\ &+ \beta_7 Availability + \boldsymbol{\beta_8} Tariff + \boldsymbol{\beta_9} Apps) \end{aligned} \quad (5.1)$$

Table 5.1: logit regression results

	(1) *intent*	(2) *intent*	(3) *intent*	(4) *intent*
age	−0.0930**	−0.0650	−0.0627	−0.0290
female	−0.297	0.545	0.506	0.256
education	−0.127*	−0.0509	−0.0410	−0.0757
occupation				
employed	0.736	0.0676	0.237	−0.467
self-employed	0.544	−0.765	−0.562	−2.379
income				
10 001 – 20 000	0.378	0.369	0.236	0.461
20 001 – 30 000	0.104	0.747	0.529	−0.578
30 001+	1.412*	1.143	0.898	−0.145
smartphone		3.120**	2.889**	4.428*
availability		0.293	0.288	0.0343
tariff				
company		1.780*	1.727*	2.914*
family		2.600*	2.513*	2.876†
unlimited		2.265*	2.301*	3.370*
other		2.915**	2.862**	4.441**
apps				
only e-mail		0.849	0.861	2.764
rarely		1.928*	2.023*	3.569*
only with Wi-Fi		−1.483†	−1.564†	−3.015*
everyday		3.759**	3.644**	4.898**
socialmedia			0.135	0.731
chatapp			0.143	−0.00928
mobilephone				0.661
laptop				2.944*
tablet				1.131
PC				−0.754
T-Mobile				1.486
O2				1.614
Vodafone				1.969
virtual				2.548
workwifi				−2.919*
speed				−0.117
freewifi				0.287
hoursonline				0.179†
access2				
smartphone/tablet				1.539
Constant	4.639**	−3.247	−3.467	−8.541†
Observations	237	237	237	237
Df	8	18	20	33
Chi-square	34.34**	200.67**	201.16**	228.31**
pseudo R^2	0.1110	0.6487	0.6503	0.7380

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

base groups: education - elementary; occupation - student; income - 0 – 10 000; tariff - none; apps - none; access2 - laptop/PC

The final model has 237 observations and 18 degrees of freedom. The McFadden's pseudo R^2 is equal to 0.6487. The model is statistically significant with $\chi^2 = 200.67$ and $prob > \chi^2 = 0.000$.

5.1.1 Interpreting the results

The demographic variables are not individually significant in the final model.

Table 5.2 presents the PEAs and APEs of the explanatory variables[1] (excluding the demographic factors) in the final model. A lot of the variables are binary and therefore the APE are more suitable than PEA, because it does not make much sense to plug in the sample average for the binary variables as it does not represent anyone in the sample.

Table 5.2: APEs and PEAs

	PEA *intent*	APE *intent*
smartphone	0.214**	0.437**
availability	0.020	0.041
tariff		
company	0.119*	0.377*
family	0.179*	0.464**
unlimited	0.154*	0.435**
other	0.204**	0.485**
apps		
only e-mail	0.129	0.207
rarely	0.264†	0.400*
only with Wi-Fi	−0.236†	−0.292†
everyday	0.407**	0.525**
Observations	237	237

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

The following hypotheses can be tested by our final model, as the corresponding variables were not excluded by the LR tests (results of the LR tests are provided in appendix B):

Hypothesis 1.a *Ownership of a smartphone has a positive effect on the WTP for mobile internet.* This hypothesis is supported at 1% significance level. The

[1] The computation of these effects and the differences between them have been explained in section 3.2.

APE of owning a smartphone is equal to 0.437, which means that the probability of using mobile internet is on average 44% higher for individuals, who own a smartphone in comparison to those, who do not own one.

Hypothesis 5.b *Consumers' perceived importance of the availability of the connection has a positive influence on their WTP.* This hypothesis is not supported as the variable is not significant even at 10% significance level.

Hypothesis 6 *Having a monthly tariff is positively correlated with the WTP.* This hypothesis is supported at 5% significance level for a company tariff and at 1% significance level for all the other tariffs. The company tariff has also the smallest APE, this is probably caused by the fact that the consumers do not directly decide if and what kind of company tariff they use, as well as because company tariffs are not primarily used for internet data, but rather for unlimited calls. The family, unlimited and other tariffs all have very similar APEs. The correlation is strongly positive, having a tariff increases the probability of using mobile internet by approximately 40%.

Hypothesis 8 *Using mobile applications positively affects the WTP.* This is only partly supported, the significance differs for different categories. For the category which only rarely uses mobile applications requiring internet connection, the APE on the response probability is 0.400 with 5% significance level, which is two times higher than for the category using only e-mail, however that effect is not significant. Using applications only with available Wi-Fi connection is naturally negatively correlated with the WTP for mobile internet, specifically at 10% significance level. Finally, using multiple applications everyday has a positive effect on the WTP at 1% significance level with the APE equal to 0.525. Using social media and chatting applications, specifically, was not statistically significant.

5.2 Optimal tariff

To further examine the WTP of the consumers, we estimated an additional model, for which we used the configuration of optimal tariffs described in section 4.4.1. The price, that the respondent would be willing to pay for their optimal tariff, is taken as the dependent variable. Because the price is continuous, we can estimate this model with simple OLS regression. Demographic data and the preferences for optimal tariff are included as explanatory variables. The model is expressed by the following equation:

$$\begin{aligned} Price = \beta_0 + \beta_1 Age + \beta_2 Female + \boldsymbol{\beta_3} Education \\ + \boldsymbol{\beta_4} Occupation + \boldsymbol{\beta_5} Income + \\ \boldsymbol{\beta_6} FreeMinutes + \boldsymbol{\beta_7} SMS + \boldsymbol{\beta_8} Data \end{aligned} \quad (5.2)$$

We also estimated another model, with only the demographic data as explanatory variables. The results of these regressions are shown in table 5.3.

As with the logit model, estimating the intent to use mobile internet, the results do not show any significant difference between individual demographic groups. The only exception is *Education*, which has a significant negative effect on the WTP in this model. The price, that the respondents with high-school or university education are willing to pay for mobile internet, is more than 600 CZK lower in comparison to those who finished only elementary education. This could be caused by a bias in the sample, as a big part of the respondents were either students or fresh university graduates with low budgets. Another significant variable is *FreeMinutes* (at 10% significance level), the category, which represents those who prefer unlimited calls, is willing to pay more than 300 CZK. Lastly, the category of variable *Data*, which corresponds to 250 MB per month, is significant at 5% significance level and increases the WTP by more than 300 CZK. The rest of the explanatory variables did not prove to be significant.

Table 5.3: Regression results

	(1) *Price*	(2) *Price*
age	−2.021	−0.967
female	114.9†	91.25
education		
high-school	−640.1**	−623.2**
university	−700.4**	−662.2**
occupation		
employed	−13.13	−107.1
self-employed	102.9	45.3
income		
10 001 – 20 000	−40.98	−7.17
20 001 – 30 000	19.16	106.8
30 001+	89.16	145.4
free minutes		
30		104.6
60		138.3
120		297.7
240		226.1
480		87.59
unlimited		341.5†
sms		
50		24.52
100		−37.53
200		−64.45
300		42.96
500		200.3
unlimited		−25.68
data		
100 MB		78.62
250 MB		319*
500 MB		129.2
1.5 GB		120.3
3 GB		94.78
5 GB		50.57
unlimited		96.39
Constant	974.9**	636.4**
Observations	237	237
R^2	0.1221	0.2085
F	$F(9, 227) = 3.51^{**}$	$F(28, 208) = 1.96^{**}$

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

base groups: education - elementary; occupation - student; income - 0 – 10 000; free minutes, sms, data - 0

Chapter 6

Conclusion

This thesis examined the willingness to pay for mobile internet in the Czech Republic. Traditionally, the usage of mobile internet was lower in the Czech population in comparison to other European countries, but lately is has been growing.

The study was motivated by previous research done in the field of mobile telecommunication services and consumer preferences. Similar studies have been done in different countries (e.g. Dagli & Jenkins (2016) in Cyprus, Kim (2005) in Korea, Klein & Jakopin (2014) in Germany), but nothing has been written about the Czech market.

The WTP was estimated by the logit model, a key part of the estimation was to identify the factors, which significantly affects consumer behaviour in relation to mobile internet. The significant variables were *Smartphone*, which signifies the ownership of a smartphone, *Availability*, which measures consumers' perceived importance of availability of the connection, *Tariff*, which symbolize if and what kind of tariff the consumers use and finally *App*, which represents the way the consumers use mobile application. Demographic characteristics did not prove to have any significant level on the WTP.

When estimating the WTP through revealed preferences of consumers, we should note that it depends on whether there are incentives for the respondents to reveal their true WTP. And even if they do, the hypothetical WTP can differ from the actual WTP at the point of purchase. Wertenbroch & Skiera (2002) show that methods collecting data at the point of purchase or involving incentives for stating the true WTP yield lower estimates. In our data, the price the respondents would be willing to pay for their optimal tariff, corresponds to the price they pay for mobile services at the moment. The average optimal price was 360 CZK and the average monthly price paid for mobile services at the moment was 373 CZK, the median was exactly 300 CZK for both of them. This suggests that the estimated WTP is close the actual one.

As the telecommunication industry is very dynamic, further research is applicable. For instance the coverage of the Czech Republic by high speed and quality LTE signal, was very recent and the consumers are not presently using its full potential. Another possible direction for the research related to mobile internet is the expanding business sector of based on mobile applications, which focuses on people who are always connected online. Companies like Uber and AirBnB show the possibilities coming from mobile internet and have completely changed the way the services are provided.

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Appendix A

Online questionnaire

Ochota platit za mobilní internet v ČR

Willingness to pay for mobile internet in the CR

*Povinné pole

Jaká elektronická zařízení vlastníte? *
Whic electronic devices do you own?

- ☐ klasický mobilní telefon (standard mobile phone)
- ☐ chytrý telefon (smartphone)
- ☐ tablet
- ☐ notebook (laptop)
- ☐ PC
- ☐ žádné (none)
- ☐ Jiné (other)

Jaký je Váš mobilní operátor? *
Which mobile operator do you have?

- ☐ O2
- ☐ Vodafone
- ☐ T-Mobile
- ☐ Jiné (other)

Máte tarif? *
Do you have a tariff?

- [ ] Ano, firemní (yes, a company tariff)
- [ ] Ano, rodinný (yes, a family tariff)
- [ ] Ano, neomezený (yes, unlimited)
- [ ] Ano, ale žádný z předchozích (yes, but none of the above)
- [ ] Ne, používám kredit (no, I use pre-paid credit)

Kolik Kč průměrně platíte celkem za mobilní služby za měsíc? *
How much do you pay for mobile services per month in CZK?

Vaše odpověď

Kolik hodin denně strávíte na internetu v rámci práce/školy? *
How many hours a day do you spend online at work/school?

Vaše odpověď

Kolik hodin denně strávíte na internetu v rámci volného času? *
How many hours a day do you spend online in your free time?

Vaše odpověď

Jak se nejčastěji připojujete k internetu? *
How do you access the internet the most often?

- ○ Z PC/notebooku přes síťový kabel (from a PC/laptop via a network cable)
- ○ Z PC/notebooku přes WiFi (from a PC/laptop via WiFi)
- ○ Z telefonu/tabletu přes WiFi (from phone/tablet via WiFi)
- ○ Z telefonu/tabletu přes mobilní data (from phone/tablet via mobile data)

Jaké sociální sítě používáte ze svého mobilu? *
What social media do you use on your mobile phone?

- [ ] Facebook
- [ ] Twitter
- [ ] Instagram
- [ ] Snapchat
- [ ] Žádné (none)
- [ ] Jiné (other)

Používáte nějaké aplikace umožňující komunikaci (volání, zprávy) přes internet? *
Do you use any apps for online communication (calls, chats)?

- ☐ Facebook Messenger
- ☐ Viber
- ☐ WhatsApp
- ☐ Skype
- ☐ Ne (no)
- ☐ Jiné (other)

Používáte mobilní aplikace vyžadující přístup k internetu? (např. email, mapy, jízdní řády, atp.) *
Do you use mobile apps requiring internet access? (e.g. email, maps, bus schedules, etc.)

- ○ Ano, mám jich více a používám je několikrát denně (yes, I have several and I use them everyday)
- ○ Ano, ale pouze pokud mám k dispozici Wi-Fi připojení (yes, but only with available Wi-Fi connection)
- ○ Jenom email (only email)
- ○ Vyjímečně (rarely)
- ○ Ne (no)

Máte ve škole/práci přístup k Wi-Fi připojení? *
Do you have access to Wi-Fi connection at work/school?

- ○ Ano (yes)
- ○ Ne (no)

Na stupnici od 1 do 4 označte, zda souhlasíte s následujícími výroky o připojení k internetu (1 - vůbec nesouhlasím, 4 - úplně souhlasím) *
On a scale of 1 to 4, mark if you agree with the following statements about internet connection (1 - totally disagree, 4 - totally agree)

	1	2	3	4
Je pro mne důležitá rychlost připojení.	○	○	○	○
(the speed of the connection is important to me)	○	○	○	○
Chci mít připojení neustále k dispozici.	○	○	○	○
(I want the connection to be always available)	○	○	○	○
Často využívám volně dostupné WiFi sítě (v obchodních centrech, restauracích, dopravních prostředcích, apod.)	○	○	○	○
(I often use public Wi-Fi hotspots)	○	○	○	○

Využíváte připojení k internetu přes mobilní data? *
Do you use internet connection via mobile data?

- Ano (yes)
- Ne (no)

Kolik MB dat průměrně využijete za měsíc (nezahrnujte připojení přes WiFi)? *
How many MB per month do you use on average (not including connection through WiFi)?

Vaše odpověď

Kolik Kč platíte měsíčně za mobilní internet? *
How much do you pay for mobile internet per month in CZK?

Vaše odpověď

Zde si můžete nakonfigurovat vlastní ideální balíček. Cílem je označit, kolik minut, SMS a dat opravdu využijete za měsíc a jakou cenu byste byli ochotní platit za takto Vámi nastavený balíček. (Here, you can set your optimal bundle. The aim is to mark how many free minutes, sms and data you would actually use per month and what price would you be willing to pay fo such a bundle.)

*

	0	30	60	120	240	480	neomezeno
volné minuty (free minutes)	◯	◯	◯	◯	◯	◯	◯

*

	0	50	100	200	300	500	neomezeno
SMS	◯	◯	◯	◯	◯	◯	◯

*

	0	100 MB	250 MB	500 MB	1,5 GB	3 GB	5 GB	neo
množství dat (data)	◯	◯	◯	◯	◯	◯	◯	

Cena (price) *
Prosím, napište nejvyšší cenu v Kč, jakou byste za takto Vámi nakonfigurovaný balíček byli ochotni platit. (Please, write the maximal price, that you would be willing to pay for such a bundle.)

Vaše odpověď

Pohlaví (gender) *

- ◯ Muž (male)
- ◯ Žena (female)

Věk (age) *

Vaše odpověď

Nejvyšší dosažené vzdělání (highest level of education) *

- ◯ základní (elementary)
- ◯ středoškolské (high-school)
- ◯ vysokoškolské (university)

Jsem... (occupation) *

- ◯ student
- ◯ zaměstnanec (employed)
- ◯ OSVČ (self-employed)
- ◯ nezaměstnaný (unemployed)

Nejvyšší dosažené vzdělání (highest level of education) *

- ◯ základní (elementary)
- ◯ středoškolské (high-school)
- ◯ vysokoškolské (university)

Jsem... (occupation) *

- ◯ student
- ◯ zaměstnanec (employed)
- ◯ OSVČ (self-employed)
- ◯ nezaměstnaný (unemployed)

V jakém rozmezí se pohybuje Váš čistý měsíční příjem? *
At which range is your monthly income?

- ◯ 0 - 10 000 Kč
- ◯ 10 001 - 20 000 Kč
- ◯ 20 001 - 30 000 Kč
- ◯ 30 001 Kč a více

Appendix B

Results

B.1 LR tests

```
logistic intent age female education i.occupation i.income
        estimates store m1
logistic intent age female education i.occupation i.income
smartphone
        estimates store m2
        lrtest m1 m2
logistic intent age female education i.occupation i.income
smartphone tablet
        estimates store m3
        lrtest m2 m3
logistic intent age female education i.occupation i.income
smartphone laptop
        estimates store m4
        lrtest m2 m4
logistic intent age female education i.occupation i.income
smartphone pc
        estimates store m5
        lrtest m2 m5
logistic intent age female education i.occupation i.income
smartphone mobilephone
        estimates store m6
        lrtest m2 m6
logistic intent age female education i.occupation i.income
```

```
smartphone tmobile
        estimates store m7
        lrtest m2 m7
logistic intent age female education i.occupation i.income
smartphone o2
        estimates store m8
        lrtest m2 m8
logistic intent age female education i.occupation i.income
smartphone vodafone
        estimates store m9
        lrtest m2 m9
logistic intent age female education i.occupation i.income
smartphone virtual
        estimates store m10
        lrtest m2 m10
logistic intent age female education i.occupation i.income
smartphone workwifi
        estimates store m11
        lrtest m2 m11
logistic intent age female education i.occupation i.income
smartphone i.tariff
        estimates store m12
        lrtest m2 m12
logistic intent age female education i.occupation i.income
smartphone i.tariff speed
        estimates store m13
        lrtest m12 m13
logistic intent age female education i.occupation i.income
smartphone i.tariff availability
        estimates store m14
        lrtest m12 m14
logistic intent age female education i.occupation i.income
smartphone i.tariff availability freewifi
        estimates store m15
        lrtest m14  m15
logistic intent age female education i.occupation i.income
smartphone i.tariff availability socialmedia
```

```
        estimates store m16
        lrtest m14 m16
logistic intent age female education i.occupation i.income
smartphone i.tariff availability chatapp
        estimates store m17
        lrtest m14 m17
logistic intent age female education i.occupation i.income
smartphone i.tariff availability i.apps
        estimates store m18
        lrtest m14 m18
logistic intent age female education i.occupation i.income
smartphone i.tariff availability i.apps hoursonline
        estimates store m19
        lrtest m18 m19
logistic intent age female education i.occupation i.income
smartphone i.tariff availability i.apps access2
        estimates store m20
        lrtest m18 m20
```

Table B.1: Likelihood-ratio tests results

Likelihood-ratio test (Assumption: m1 nested in m2)	LR chi2(1) = 47.18 Prob > chi2 = 0.0000
Likelihood-ratio test (Assumption: m2 nested in m3)	LR chi2(1) = 0.88 Prob > chi2 = 0.3481
Likelihood-ratio test (Assumption: m2 nested in m4)	LR chi2(1) = 2.64 Prob > chi2 = 0.4045
Likelihood-ratio test (Assumption: m2 nested in m5)	LR chi2(1) = 0.77 Prob > chi2 = 0.3813
Likelihood-ratio test (Assumption: m2 nested in m6)	LR chi2(1) = 0.76 Prob > chi2 = 0.3835
Likelihood-ratio test (Assumption: m2 nested in m7)	LR chi2(1) = 3.27 Prob > chi2 = 0.0705
Likelihood-ratio test (Assumption: m2 nested in m8)	LR chi2(1) = 0.94 Prob > chi2 = 0.3316
Likelihood-ratio test (Assumption: m2 nested in m9)	LR chi2(1) = 0.51 Prob > chi2 = 0.4755
Likelihood-ratio test (Assumption: m2 nested in m10)	LR chi2(1) = 0.00 Prob > chi2 = 0.9560
Likelihood-ratio test (Assumption: m2 nested in m11)	LR chi2(1) = 3.75 Prob > chi2 = 0.0527
Likelihood-ratio test (Assumption: m2 nested in m12)	LR chi2(1) = 24.93 Prob > chi2 = 0.0001
Likelihood-ratio test (Assumption: m12 nested in m13)	LR chi2(1) = 0.001 Prob > chi2 = 0.9117
Likelihood-ratio test (Assumption: m12 nested in m14)	LR chi2(1) = 12.92 Prob > chi2 = 0.0003
Likelihood-ratio test (Assumption: m14 nested in m15)	LR chi2(1) = 0.17 Prob > chi2 = 0.6783
Likelihood-ratio test (Assumption: m14 nested in m16)	LR chi2(1) = 3.31 Prob > chi2 = 0.0769
Likelihood-ratio test (Assumption: m14 nested in m17)	LR chi2(1) = 0.72 Prob > chi2 = 0.3959
Likelihood-ratio test (Assumption: m14 nested in m18)	LR chi2(1) = 81.29 Prob > chi2 = 0.0000
Likelihood-ratio test (Assumption: m18 nested in m19)	LR chi2(1) = 4.74 Prob > chi2 = 0.0292
Likelihood-ratio test (Assumption: m18 nested in m20)	LR chi2(1) = 0.27 Prob > chi2 = 0.6030