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Broadband: What do consumers want? Examining willingness-to-pay for next-generation mobile broadband services

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Abstract

Recently, fourth-generation mobile networks have gained traction. Those new mobile services offer speed comparable to existing fixed broadband access. This convergence in speed of mobile and fixed broadband puts in question the need for consumers to be subscribed to two separate services for fixed and mobile access.

This study investigates the willingness-to-pay for mobile broadband as well as consumers' willingness to give up speed for the flexibility of having their “regular” internet access with them. A choice experiment is designed before analyzing the results from the experiments by estimating a random utility model and using the coefficients to analyze competitive strategies in the market. The analysis of the data shows that mobile capabilities seem to matter more to consumers than additional speed.

Keywords: mobile broadband, discrete choice experiment, willingness-to-pay. product differentiation

1. Introduction

The introduction of "fourth-generation" LTE (long-term evolution) wireless technology in Europe and across North America brings up questions as to what extent future wireless internet access is bound to replace traditional broadband connections. This work aims to contribute to the discussion about complementarity of fixed and mobile internet access by modeling the choice between the two options using a random utility model.

Before UMTS and other 3G technologies became widespread, mobile internet has not played a significant role as data transmission rates were too low to comfortably accommodate common internet tasks. While in practice, 3G networks do not reach transfer speed comparable with modern DSL or cable lines, they do facilitate every day internet use, including basic media consumption such as low-resolution streaming video, listening to music and viewing pictures. With modern 4G networks, mobile data rates will likely rival those of current fixed line broadband.

Besides lower transmission speed, availability of mobile internet-capable devices such as smartphones and tablets has been scarce. New 4G networks not only enable consumers to have one single plan for internet access, it also allows to take the internet connection anywhere where coverage is provided. This study uses stated preference methods to investigate how much consumers are willing to pay for broadband access with mobile capabilities and whether 4G is perceived by consumers as a substitute or complement to existing services. A sample of respondents has been presented with different choices between hypothetical broadband plans. The data has then been analyzed by estimating a random utility model and using the resulting logit coefficients to assess competitive strategies in the market. The analysis of the data shows that mobile capabilities seem to matter more to consumers than additional speed. Projecting market shares for hypothetical markets shows that a marginally faster plan offering mobile capabilities is valued more than a dramatically faster plan without mobile. The strategy implications for firms are that additional investment in fixed-line infrastructure pays off less in terms of market share than investments in mobile infrastructure.

The remainder of this study is organized as follows. First, an overview over relevant literature is given. Then, the methodology to implement the choice experiment and estimate willingness-to-pay is described. Before concluding, estimation results are presented and discussed.

2. **Literature Review**

While contributions dealing with the demand for next-generation mobile services are scarce due to the novelty of the technology, there is a considerable body of literature examining demand and willingness-to-pay for regular broadband.

Madden and Simpson (1997) analyze early broadband adoption factors using stated preference data. Their estimation of a discrete choice model suggests price and income to be the most relevant factors in early adoption of fixed broadband in Australia. Rosston et al. (2010) estimate US household preferences for broadband access using a random utility model. They combine market data with data obtained from choice experiments to estimate the valuation of internet services and the influence of different broadband connection characteristics on consumers' willingness-to-pay. They find speed and reliability to be important, with more experienced (i.e. technologically apt) households willing to pay more for premium service. While Rosston et al. (2010) focus on the marginal valuations of service specifics, Ida and Sato (2006) investigate preferences for different technologies of broadband access with conjoint analysis and find that the availability of a particularly fast technology might lower willingness-to-pay for all types of broadband access. Also comparing access technologies, Ahn et al. (2006) study consumer preferences in South Korea regarding mobile (cellular) data transmission and wireless LAN using a random utility model. While finding that consumers prefer wireless LAN to cellular data due to higher up- and download speeds, they acknowledge that this preference might be linked to device availability and prices at the time of the study. They also find consumers to prefer devices supporting both data transmission technologies.

Brown and Lee (2008) compare different factors influencing the adoption of broadband between several OECD countries in 2004 and 2005. While methodologically different to the above-mentioned studies by relying on ex-post observed market data, their findings suggest wireless data to neither complement nor substitute fixed internet access. The authors infer this from regression results from mobile price on fixed broadband diffusion, although suggesting that this relationship might change as mobile data transmission becomes faster over time. While the work of Cardona et al. (2009) is concerned primarily with market definition and estimation of demand elasticity in a regulatory context, the authors do suggest that mobile broadband might become a substitute to other forms of broadband access, once it gains traction.

Brown and Lee (2008) as well as Cardona et al. (2009) suggest that the then relatively slow data transmission speed of cellular networks might have hindered mobile broadband offerings from directly competing with fixed broadband access.

Based on these findings, this study aims to give at least anecdotal evidence as to what extent the increased availability of mobile computing devices and higher cellular data transmission rates have changed consumer preferences. Specifically, marginal willingness-to-pay for mobile broadband and the willingness to "trade-in" speed for mobile availability are to be examined.

3. Research methodology and empirical model

3.1. Fixed and mobile broadband in Germany

As of early 2012, there are several broadband access options available to German consumers. Fixed line offerings include broadband via TV cable as well as different forms of DSL (e.g. ADSL, VDSL). These connections are typically available in most areas at different speeds between 3 mBit/s and 50 mBit/s, with some rural regions lacking ADSL/cable and thereby any fixed broadband access. Mobile access to broadband internet can be either obtained via 3G UMTS/HSDPA or 4G LTE – however, coverage and speed vary significantly across regions – especially for LTE, which is not yet fully established in the market. 3G connections typically achieve average download speeds at around 1 mBit/s, which is still significantly lower than most DSL lines but suffices for basic communication and media consumption purposes. In general, fixed broadband tends to be inflexible yet faster, where mobile options offer more flexibility at lower speed. Future generation mobile network technologies are expected to combine advantages of the two – it is unclear though to which extent consumers perceive faster mobile access as a viable alternative to a conventional DSL or cable connection and what effect the ability to attain high data transfer rates away from home has on willingness-to-pay.

3.2. Methodology

A large part of literature in economics makes use revealed preference (RP) methods, where consumers' preferences are inferred ex-post from observed market data. One major advantage of RP methods is that bias is reduced by definition as the underlying data captures actual market actions. However, RP falls short in cases where market data is scarce or not available at all. This is regularly the case for new products like mobile broadband, in this case 4G networks. Stated preference (SP) methods provide an alternative approach by observing consumers' choices over a hypothetical set of alternatives with different attributes and levels. The hypothetical nature of SP methods enables researchers to capture consumer preferences that are not yet met by market supply, making SP approaches popular in new product development and marketing research. Internet access markets are very dynamic and rapidly changing. Thus, obtaining sufficient data for RP methods is not always feasible, especially when considering types of mobile broadband access like LTE that are not yet available to a majority of the population. SP methods do have some drawbacks, however. For example, consumers' stated preferences might differ from their actual preferences (Wardman, 1988), leading to biased results. Furthermore, the way data for SP based studies is usually collected (usually by either directly interviewing candidates or online or by mail) gives rise to problems inherent to the respective method – for example, respondents can easily fatigue during a lengthy and repetitive choice task in front of a computer. In addition, validity of SP data is hard to measure, as comparisons with corresponding RP data is not always feasible (Wardman, 1988) Despite these disadvantages, using a SP approach seems appropriate in this case, given the possibility to control the experiment and the reduced cost of obtaining sufficient data (Kroes and Sheldon, 1988, p. 13).

3.3. Questionnaire design and implementation

To obtain the data needed for analysis, a web-based survey has been set up and distributed online. Respondents were presented questions about their general usage behavior and demographics as well as engaging them in 16 choice experiments. These experiments reflected the trade-off between mobility and speed with price as constraint described earlier. Respondents were asked to choose between hypothetical mobile and fixed internet services with varying speed and price levels. These choices reveal information about the relative importance of broadband access characteristics and to what extent mobile and fixed access are perceived as substitutes to one another. The levels of the attributes have been constructed as follows:

Price: monthly subscription fee in Euro with levels between 15 and 50 Euros (in 5 Euro increments). The maximum and minimum price levels are roughly reflective of current residential broadband and mobile data offerings in Germany.

Speed: As actual speed varies immensely depending on location and consumers do not intuitively interpret transfer rates, different categories of speed with names descriptive of their relative speed are created (see Rosston et al., 2010 for a similar approach). The attribute levels have been derived from current market offers. As of April 2012, most German internet providers offer 2-4 speed categories. The slowest plans all fall into a range of up to 6 mBit/s and the regular plans offer up to around 6 mBit/s. Most provide also faster plans up to 16 mBit/s as well as fiber optics access with significantly higher up- and downlink speed as a fourth category of plans. In this study, respondents have been presented with plans that are "slow" (up to 3 mBit/s), "normal"(3 – 6 mBit/s), "fast" (6 – 16 mBit/s) or "extremely fast" (more than 16 mBit/s).

Mobile denotes whether a connection allows for mobile and home usage simultaneously and takes two values, "yes" and "no". A plan described as mobile in the setting of the experiment enables the consumer to use the internet connection outside her residence. That may be achieved by carrying the internet modem to another place (e.g. a hotel room) or by creating personal hotspots over a smartphone.

Combining the three attributes into broadband plans, there are 48 (k_1 x k_2 x k_3 = 6 x 4 x 2) alternatives.

Running a choice experiment using the full factorial with 48 subsequent tasks to complete would most likely put too much cognitive burden on the respondents. The alternative is to reduce the number of tasks such that the information about preferences regarding the choice sets left out can be inferred from the choice tasks that have actually been shown to respondents (Carson and Louviere, p.201). Such a reduced set of choices is called a fractional factorial.

In this case, a fractional factorial design with 16 choice sets has been generated using the Federov algorithm following Aizaki and Nishimura (2008). The design has then been copied and a random number has been assigned to each row and each line. The resulting choice pairs were then matched by hand to minimize logical flaws such as dominated alternative. Such flaws are relatively common as there is always a certain likelihood of hypothetical plans being paired where one option strictly dominates the other (e.g. one plan offering faster speeds all other things equal). From the 16 choice pairs, two pairs still exhibited dominated alternatives. Also, the resulting design is slightly unbalanced regarding the occurrence of levels of *Price* and *Speed*. Ideally, the design would be balanced in levels, orthogonal and without any dominated alternatives (Carson and Louviere, 2010, p. 205-206). As this is not always possible, minimizing those unwanted properties seemed appropriate. Carson and Louviere (2010, p.205) further name correlation between attributes as a desirable property – in the case of the attributes used in this study, this seems to be less of an issue as all three attributes can be assumed to be varied independently. Figure 1 shows a full overview over the final 16 choice experiments.

Besides the 16 choice experiments, respondents were asked about their general internet usage as well as current plans. Specifically, they were asked to "locate" their own broadband plan within the choice experiment's attributes and levels before the actual experiment. Further questions dealt with mobile usage and general usage patterns to determine speed and mobility needs.

After completing the choice experiment section, demographic data such as age, place of living (urban, suburban, rural), income and household size have been collected.

Those questions serve two purposes: First, they give a general idea about the sample composition. Secondly, they serve as control variables to test the validity of assumptions regarding mobile usage. To clarify the attribute levels of both "Speed" and "Mobile", an explanatory screen has been shown before the actual choice experiment.

The resulting questionnaire has then been transferred into an online survey using Limesurvey (see figure 2 for a sample question and the appendix for the full questionnaire).

3.3. Empirical Model

In order to measure the impact of mobile availability and the trade-off with speed on willingness-to-pay, first a random utility model is estimated using a logit regression. Then, marginal willingness-to-pay for mobile availability and "willingness-to-give-up-speed" are calculated using the estimated parameters of the model. Here, an approach similar to Ida and Sato (2006) is followed. McFadden (1974, p.311) describes a model where individuals (denoted *j*) choose from alternatives sets (denoted *i*), with each alternative set being represented by an attribute vector (*x*). Consumers have a random utility function composed of a non-stochastic (observable) and stochastic (non-observable) component $U_{ij} = V(x_{ij}) + \varepsilon_{ij}$. Assuming that consumers maximize their utility, the probability of a consumer choosing any alternative *i* (i.e. $U_{ij} > U_{-ij}$: the probability of the utility of alternative *i* is higher than the utility of any other alternative not i) is given by

$$P_{ij} = Prob\,[V(x_{ij}) + \varepsilon_{ij} > V(x_{-ij}) + \varepsilon_{-ij}] =$$

$$Prob\,[\,\varepsilon_{ij} - \varepsilon_{-ij} > V(x_{-ij}) - V(x_{ij})] \qquad (1)$$

Following McFadden (ibid, p. 312) in assuming iid error terms with a Weibull distribution, the equation above collapses to the conditional logit model

$$P_{ij} = exp(V) / \sum^{i} exp(V) \qquad (2)$$

The model is then estimated maximizing the log-likelihood function

$$ln\ L = \sum^{j}\sum^{i} ln\ P_{ij} \qquad (3)$$

Assuming a linear approximation of the non-stochastic part $V(x_{ij})$ of the utility function (Rosston et al., 2010, p.9 and Ida and Sato, 2006, p.9), one can rewrite

$$V(x) = \sum^{k} \beta_k X_k \qquad (4)$$

with X_k being the k-th attribute and β_k being the estimated parameter for the corresponding attribute. Plugging in the attributes derived in the previous section (*k=1* for "price", *k=2* for "speed", *k=3* for "mobile") allows calculating willingness-to-pay (WTP) as well as willingness-to-give-up-speed (WTGUS). The values of X_k correspond to the levels for the respective attribute as described in section 3.3. The willingness-to-pay for getting mobile access on an otherwise similar plan is

$$\beta_{Price} (X_{Price} + WTP) + \beta_{Speed} X_{Speed} + \beta_{Mobile} X_{Mobile} =$$
$$\beta_{Price} X_{Price} + \beta_{Speed} X_{Speed} + \beta_{Mobile} (X_{Mobile} + 1) \qquad (5)$$

Solving for WTP yields

$$WTP = - \beta_{Mobile} / \beta_{Price} \qquad (6)$$

Similarly, one can construct a measure how much speed a consumer is willing to lose if compensated by the option of making her broadband connection mobile.

$$\beta_{Price} X_{Price} + \beta_{Speed} (X_{Speed} - WTGUS) + \beta_{Mobile} XMobile =$$
$$\beta_{Price} X_{Price} + \beta_{Speed} X_{Speed} + \beta_{Mobile} (X_{Mobile} + 1) \qquad (7)$$

Again, the equation simplifies to

$$WTGUS = \beta_{Mobile} / \beta_{Speed} \qquad (8)$$

4. Estimation

4.1. Data

The survey has been online and active between early and mid May 2012, yielding a total of 59 entries with completed choice tasks (6 respondents did not complete the choice experiment and were omitted). Respondents have been recruited using Facebook. Needless to say, generalizing the results of a sample size of 59 to the entire population is likely to produce biased results. Literature on sample size requirements for stated preference methods is relatively scarce and there seems to be no consensus on minimum sample sizes for DCEs. Bliemer and Rose (2005) show a wider range of levels produces more reliable results and suggest methods to calculate minimum required sample size. Orme (2010) suggests a sample size of at least 150 respondents for conjoint analysis and mentions Johnson's rule of thumb, stating that the product of respondents, number of choice alternatives and number of choice tasks divided by the largest product of levels of any two attributes should be larger than 500 (Johnson and Orme, 1996). In this case, this rule of thumb would yield *(59*2*16/6*4) = 79,* meaning this study falls short in terms of required sample size.

The raw data has been transformed into a format suitable for R's *clogit* function by creating a stratification variable (Aizaki and Nishimura, 2008) in order to estimate the model described in the previous section[1].

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1 The full dataset as an export from Limesurvey as well as the curated dataset used for analysis in R (both in CSV data format) can be found at: http://dl.dropbox.com/u/19785570/thesis.zip

A copy of the survey is also online for reviewing purposes at http://masterarbeit-dsl.de/umfrage-wp/umfrage/ (in German)

The sample is not representative of the general population and skewed towards a young, urban demographic. 64% of respondents were women. Most respondents live in urban (62%) or suburban (28%) areas and small households (60% with less than three members). 29% of respondents reported a monthly net disposable income of 1,301 – 2,000 Euro (24% less than 1,300, 31% more than 2,000). About 65% of the respondents were less than 30 years old. While browsing and email are standard (97%), almost half use the internet for more bandwidths intensive activities such as downloading media (43%) and video-chatting (47%). Smartphone- and mobile penetration among this sample is relatively high. 92% own a laptop computer, almost two thirds (62%) use a smartphone. A similar number (57%) is already subscribed to a mobile data plan. The majority of respondents has a fixed broadband connection of up to 16 mBit/s, costing less than 30 Euros per month. Table 3 gives an overview over the sample's demographics and usage behavior.

4.2. **Estimation Results**

Table 4 shows the estimated coefficients, standard errors, z- and P-values as well as the WTP/WTGUS calculations for three conditional logit models.

In the first model, only the attributes *PRICE*, *SPEED* and *MOBILE* were considered. For this model, coefficients for all three attributes are extremely statistically significant. *PRICE* has the expected negative sign (-0.477), implying that all other things equal, a higher priced plan yields a lower utility level than a cheaper one. Considering the strength of the effects of *SPEED* (0.736) and *MOBILE* (0.958), it appears that a broadband plan offering mobile capabilities increases utility, as does a faster connection.

The amount consumers are willing to pay for a unit change in mobile (i.e. for a broadband plan that offers mobile capabilities on top) is 2.01 Euro, willingness-to-give-up-speed has a value of 1.302.

In model 2 an interaction term has been introduced to measure differences to users who currently own a smartphone. Still, all coefficients are highly significant and similar in strength to the estimated coefficients in model 1. The strength of *MOBILE* (0.476) is still positive, yet much smaller than in model 1. The interaction term between *MOBILE* and *SMARTPHONE* is larger (0.779) than the effect of *MOBILE* alone. This interaction term measures the effect of current smartphone ownership on the valuation of mobile capabilities in a broadband plan. Looking at the WTP/WTGUS values, it is apparent that owners of smartphones are not only willing to pay more for mobile capabilities (1.613 vs. 0.967 for all respondents) in a broadband plan but are also willing to give up speed for that functionality (1.046 vs. 0.627 for all respondents).

In a third model, more interaction terms have been added. Most notably, *PRICE* interacts with *GENDER* and *AGE*. There does not seem to be a rule what demographic and respondent-specific factors to include in the analysis – in this case, this study follows Dippon (2010, p.9), who refers to age and gender as the most commonly used socio-demographic factors. Furthermore, the hypothesis that population density affects the valuation of mobile broadband has been tested by including an interaction term between the type of residential environment and *MOBILE*. Also, *SPEED* and *MOBDATA* as well as *MOBILE* and *SMARTPHONE* have been included. The rationale behind this is that respondents already owning a mobile data plan might value speed increases differently from those who do not use mobile data up to now and that smartphone ownership influences the choice between a mobile and non-mobile plan. In this model, *PRICE* (-0.508) and *MOBILE* (0.856) show significant coefficients with the expected signs, while *SPEED* does not. Moreover, the interactions between *SPEED* and *MOBDATA* (-0.179) and *MOBILE* and *SMARTPHONE* (0.817) are significant. No significant effects of *AGE* and *GENDER* on *PRICE* could be observed. Also, residential environment (*LIVING*) does not seem to influence the choice of a mobile capable broadband plan. Concerning the main attributes, *SPEED* does not show a significant coefficient anymore, while *PRICE* and *MOBILE* still do.

The latter model seems to show a decent fit as McFadden's R-squared is 0.2. In the literature, values between 0.2 and 0.4 are generally considered acceptable (McFadden, 1978, p. 307).

4.3. **Interpretation**

In the first model, speed and mobile capabilities both have significant coefficients. Apparently, penetration of mobile devices has already made mobile data a central feature of wireless communication plans. Considering that the majority of respondents currently pay less than 30 Euro per month for fixed broadband, the WTP of around 2 Euro corresponds to a 5-10% increase that consumers would be willing to accept for a mobile broadband plan over current offerings. Willingness-to-give-up-speed is not as easily interpreted, as *SPEED* in this study is constructed as an ordinal variable. One interpretation of the calculated value for WTGUS would be that consumers would be willing to accept a speed one level below their current speed if that would enable to use the broadband connection on the go in return.

Interestingly, both the willingness-to-pay and the willingness-to-give-up-speed for current users of smartphones are higher for current smartphone owners than overall. One possible explanation might be that users of smartphones are typically already subscribed to 3G data plans and value mobile broadband capabilities of 4G connections higher as they already have a need to subscribe to mobile internet, whereas the benefits of a mobile internet plan are not as obvious and more abstract for those not yet owning such a device. Smartphone owners also seem to be more willing to sacrifice in terms of speed for a “true” mobile broadband. This hints to “mobile” being a more powerful lure to current smartphone owners than “speed” - quite possibly, current speeds generally suffice for most people's usage, thus having broadband internet on the go adds more value to a subscription plan.

In the third model with interaction terms considering a wider range of socio-demographic and individual characteristics, *PRICE* and *MOBILE* show similar strength as in the other two models, hinting at relatively robust results regarding the negative impact of price on the probability of choosing a given broadband plan and the positive impact of mobile capabilities. Interestingly, SPEED alone is not significant anymore in this model, while a higher connection speed paired with mobile capabilities is. This emphasizes the increased importance of mobile relative to pure connection speed. Also, the effect of smartphone ownership on valuation of mobile capabilities is consistent with the other models. Interestingly, current subscribers of mobile data plans (irrespective of whether they use their mobile data plan in a smartphone, tablet or laptop) actually are less likely to choose a faster plan. While this could be an inconsistency stemming from the survey design and the overall quality of the data, it fits the image of speed not being the primary concern to consumers, especially those who already are “mobile”.

4.4. Market simulation

Using the coefficients from the estimated model, one can predict market shares for hypothetical markets (e.g. Berry, 1994, p. 248). Equation *(2)* can be used to calculate hypothetical market shares, where the share of a product *i* is its estimated utility over the sum of the estimated utility levels of all products in this market:

$$s_i = e^{U_i} / \sum^j e^{U_j}$$

This allows analyzing the market’s reaction to product changes. Table 5 shows two markets – in market A, there are three broadband providers, offering plans with different speeds (the faster, the more expensive). Now we assume that provider 2 wants to invest in her network and has to make a strategic decision: Either match provider 1’s speed with a mobile data plan or offer an even faster connection that is fixed (markets B1 and B2), in both cases charging a significantly higher price to cover the cost of the investment in infrastructure. Using the estimation results from model 1, “mobile” as a competitive differentiator would increase provider 2’s market share by 10%, while offering a particularly fast plan would yield an increase of just 2%, underlining the earlier finding that for consumers “mobile” is now more important than “speed”.

Calculating price elasticities for the two alternatives (table 6) shows that the mobile plan has a larger inelastic part of the demand curve. Mobile options on broadband plans seem to allow providers to defend market share in spite of price increases.

5. Conclusion

To analyze willingness-to-pay for 4G mobile broadband, a choice experiment has been carried out online and data regarding broadband choice, internet usage patterns and current fixed and mobile service subscription has been obtained. Estimation of a random utility model provides anecdotal evidence regarding willingness-to-pay and -to-give-up-speed of a small sample of younger, urban German consumers. Most notably, those consumers seem to be willing to pay an extra fee to enable mobile broadband access. Also reductions in speed in exchange for mobile access seem to be accepted. Mobility of broadband seems to outperform speed as the primary selling point of internet access as mobile devices continue to gain traction. Intuitively, current residential broadband is fast enough for most consumers, such that increases in speed do not add as much value as a potentially disruptive feature like full mobile usage would. For internet service providers, the consequence is most likely that racing to be the fastest ISP will become an increasingly ineffective strategy and large investments in fixed-line infrastructure seem questionable.

Tables

Table 1. **Choice pairs**

		Plan A			Plan B	
Question	**Price**	**Speed**	**Mobile**	**Price**	**Speed**	**Mobile**
1	20 Euro	slow	yes	30 Euro	very fast	No
2	35 Euro	very fast	yes	30 Euro	normal	Yes
3	20 Euro	normal	no	30 Euro	slow	No
4	45 Euro	slow	yes	35 Euro	fast	No
5	40 Euro	normal	yes	30 Euro	slow	No
6	25 Euro	fast	yes	40 Euro	very fast	Yes
7	30 Euro	very fast	no	20 Euro	normal	No
8	40 Euro	very fast	yes	25 Euro	normal	No
9	20 Euro	fast	no	25 Euro	very fast	No
10	35 Euro	normal	yes	20 Euro	slow	Yes
11	25 Euro	normal	no	45 Euro	fast	No
12	35 Euro	fast	yes	25 Euro	fast	Yes
13	25 Euro	very fast	no	45 Euro	slow	Yes
14	40 Euro	slow	no	45 Euro	slow	Yes
15	45 Euro	fast	no	40 Euro	slow	Yes
16	25 Euro	very fast	no	20 Euro	fast	Yes

Table 2. **Sample choice experiment question**

Considering the following two broadband plans, which would you prefer?

	Plan A	**Plan B**
Price	40 Euro	25 Euro
Speed	Very fast (more than 16 mBit/s)	normal (up to 6 mBit/s)
Mobile usage possible	yes	no

Please choose one of the following Answers.
0 Plan A
0 Plan B
0 Neither

Table 3. Descriptive Statistics

How old are you?	Percentage
18 – 24 years	16 %
25 – 29 years	49 %
30 – 39 years	19 %
40 – 49 years	7 %
50 – 59 years	9 %
60 and up	0 %

What is your gender?	Percentage
male	36 %
female	64 %

How is your place of living best described?	Percentage
Urban	62 %
Suburban/Small City	28 %
Rural	10 %

What is you monthly net disposable income?	Percentage
up to 1,300 Euro	24 %
1,301 – 2000 Euro	29 %
2,001 – 3200 Euro	26 %
more than 3,200 Euro	5 %
no answer	16 %

How many persons live in your household?	Percentage
1	22 %
2	38 %
3	29 %
4	9 %
more than 4	2 %

Which internet-capable devices do you use?	Percentage
Smartphone	62 %
Tablet	15 %
Laptop	92 %
PC	43 %
Mobile gaming device	5 %

What activities do you mainly use the internet for?	Percentage
E-Mail and browsing	97 %
Downloading media (music, video, etc.)	43 %
Watching TV and streaming movies	23 %
Video-chatting and telephony	47 %
Gaming	13 %

Are you subscribed to a mobile data plan?	Percentage
yes	57 %
no	20 %
no answer	23 %

How fast is your current fixed broadband connection?	Percentage
Slow (up to 3 mBit/s)	3 %
Normal (3 to 6 mBit/s)	27 %
Fast (6 to 16 mBit/s)	37 %
Very fast (more than 16 mBit/s)	17 %
I don't know	17 %

What is the cost of you current fixed broadband connection?	Percentage
below 20 Euro	27 %
21 – 25 Euro	20 %
26 to 30 Euro	27 %
31 – 35 Euro	7 %
36 – 40 Euro	9 %
above 40 Euro	11 %

Table 4. Logit regressions

Model 1

Variable	Coefficient	S.E.	z	P > |z|
PRICE	-0.477	0.0337	-14.15	0.0000
SPEED	0.736	0.0447	16.45	0.0000
MOBILE	0.958	0.1143	8.38	0.0000

Likelihood ratio test=392 on 3 df, p=0 n= 2832, number of events= 944

WTP for mobile: - (0.958)/(-0.477) = 2.008

WTGUS for mobile: (0.958)/(0.736) = 1.302

Model 2

Variable	Coefficient	S.E.	z	P > |z|
PRICE	-0.483	0.0339	-14.22	0.00000
SPEED	0.745	0.0451	16.52	0.00000
MOBILE	0.476	0.1698	2.81	0.00500
MOBILE*SMARTPHONE	0.779	0.2047	3.81	0.0001

Likelihood ratio test=406 on 4 df, p=0 n= 2832, number of events= 944

WTP for mobile*smartphone: - (0.779)/(-0.483) =1.613

WTGUS for mobile*smartphone: (0.779)/(0.745) = 1.046

WTP for mobile: - (0.467)/(-0.483) =0.967

WTGUS for mobile: (0.467)/(0.745) = 0.627

Model 3

	Coefficient	S.E.	z	P > |z|
PRICE	-0.5084	0.0587	-8.67	0.0000
SPEED	0.2136	0.2607	0.82	0.4100
MOBILE	0.8564	0.0598	14.32	0.0000
PRICE*GENDER	-0.0617	0.0409	-1.51	0.1300
PRICE*AGE	0.0244	0.0166	1.47	0.1400
MOBILE*LIVING	0.1695	0.1582	1.07	0.2800
SPEED*MOBDATA	-0.1794	0.0611	-2.93	0.0033
MOBILE*SMARTPHONE	0.8165	0.2167	3.77	0.0002

Likelihood ratio test=420 on 8 df, p=0 n= 2832, number of events= 944

Log-likelihood at zero (L_0) = -1037.0900 and at convergence (L_1) = -827.1094

McFadden's $R^2 = 1 - (L_1/L_0) = 1 - (-827.1094 / -1037.0900) = 0.2025$

WTP for mobile: - (0.508)/(-0.856) = 0.594

WTP for speed*mobdata: - (0.508)/-(-0.179) = - 2.838

WTP for mobile*smartphone: - (0.508)/(-0.817) = 0.622

Table 5. Simulated markets

Market A

	Estimated utility	PRICE	SPEED	MOBILE	Estimated market share
Network 1	0.777	25 Euro	fast	no	50%
Network 2	**0.518**	**20 Euro**	**normal**	**no**	**33%**
Network 3	0.259	15 Euro	slow	no	17%
					100%

Market B1

	Estimated utility	PRICE	SPEED	MOBILE	Estimated market share
Network 1	0.777	25 Euro	fast	no	49%
Network 2 (faster)	**0.559**	**35 Euro**	**very fast**	**no**	**35%**
Network 3	0.259	15 Euro	slow	no	16%
					100%

Market B2

	Estimated utility	PRICE	SPEED	MOBILE	Estimated market share
Network 1	0.777	25 Euro	fast	no	43%
Network 2 (mobile)	0.781	35 Euro	fast	yes	43%
Network 3	0.259	15 Euro	slow	no	14%
					100%

Table 6. Price elasticity of market shares

	Market B2				**Market B1**			
Price	**Market share**	**Price change**	**Share change**	**Elasticity**	**Market Share**	**Price change**	**Share change**	**Elasticity**
1.00	72%	-33%	3%	-0.086	70%	-33%	3%	-0.089
1.50	70%	-25%	3%	-0.118	68%	-25%	3%	-0.121
2.00	68%	-20%	3%	-0.152	66%	-20%	5%	-0.238
2.50	66%	-17%	5%	-0.286	63%	-17%	7%	-0.407
3.00	63%	-14%	7%	-0.475	59%	-14%	7%	-0.509
3.50	59%	-13%	7%	-0.582	55%	-13%	10%	-0.800
4.00	55%	-11%	10%	-0.900	50%	-11%	16%	-1.465
4.50	50%	-10%	16%	-1.628	43%	-10%	23%	-2.286
5.00	43%	-9%	26%	-2.912	35%	-9%	46%	-5.042
5.50	34%	-8%	48%	-5.739	24%	-8%	243%	-29.143
6.00	23%				7%			

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