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Working Paper

Irrationality rings! - Experimental evidence on mobile tariff choices

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DISCUSSION PAPER

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Editor:

Prof. Dr. Hans-Theo Normann
Düsseldorf Institute for Competition Economics (DICE)
Phone: +49(0) 211-81-15125, e-mail: normann@dice.uni-duesseldorf.de

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Irrationality Rings! - Experimental Evidence on Mobile Tariff Choices

Anne-Kathrin Barth * Julia Graf **

November 15, 2011

Abstract

This paper investigates why consumers choose calling plans that are not always cost-minimizing. Our approach is twofold: we account for general difficulties facing a tariff choice, as well as for biased preferences. We provide evidence from an experiment among German university students and staff, finding that participants are often not aware of their actual consumption. In line with the findings on flat-rate biases, respondents systematically overestimate their consumption. On the other hand, they are generally able and willing to detect optimal tariffs. Furthermore, with increasing usage level, consumers' performance improves. However, some participants hold strong preferences for certain tariff forms, seducing them to choose cost-dominated offers. In our setup, we find that respondents prefer tariffs involving subsidies or hire-purchase options for handsets over contracts with buy now options.

Keywords: Behavioral Economics, Mobile phone tariffs, Handset subsidy, Hire-purchase of device

*Duesseldorf Institute for Competition Economics (DICE), e-mail: anne-kathrin.barth@dice.uni-duesseldorf.de

**Duesseldorf Institute for Competition Economics (DICE), e-mail: julia.graf@dice.uni-duesseldorf.de.

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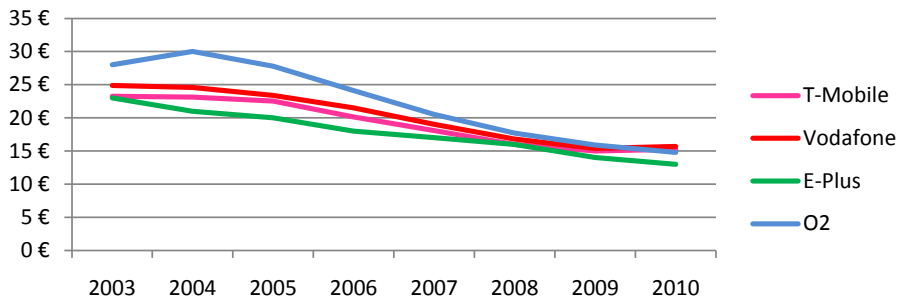
1 Introduction

The mobile telecommunications market in Germany is characterized by fierce competition among the four network operators T-Mobile, Vodafone, E-Plus and o2. Although the German market is nearly saturated, the penetration rates are still increasing. Statistically every German possesses 1.3 mobile contracts today. This development is mainly driven by continuous price cuts, particularly by discount offers (Bundesnetzagentur 2009, p. 50ff). Hence, the average revenues per subscriber (ARPU) are decreasing. Figure 1 shows that the average monthly ARPU has declined by approximately 40% between 2003 and 2010.

Figure 1: Development of the monthly ARPU in Euro



Source: Merrill Lynch (2010)

New tariff structures become necessary for the network operators to stay profitable. One of these innovations is the abolition of handset subsidies, which are very costly for the operators (Kruse, Haucap and Dewenter 2004). Especially, smaller providers face high costs due to lower capacity utilization, caused by fewer subscribers and voice volumes. Therefore, E-Plus and o2 started to sell tariffs which do not include the corresponding mobile device. Deferred payments with low, or even no, interest payments are also offered. The following table 1[1] summarizes the different tariff structures offered for a similar mobile device, here the iPhone. Mobile phone tariffs generally comprise and vary in prices for monthly subscription, usage and handsets. The first-movers T-Mobile and Vodafone who still account for 65% of the market share (Bundesnetzagentur 2009), continue to subsidize mobile devices, whereas the smaller operator o2 sells the same

[1]Vodafone's tariff SuperFlat Internet Allnet differs in some minor points from T-Mobile's tariff Complete Mobile XL. The data flat rate is limited after 2 GB, the SMS flat rate is unlimited (more than 3000 SMS) and 1500 MMS are included. The o2 o tariff is a a pay-per-use contract with a cost cap at 50 EURO, meaning the customers bill is limited to 50 EURO, the Internet L Package costs 15 EURO per month

handset without discounts. Using the assumptions of the OECD high-usage basket (OECD 2009), we find that o2 tariffs generate lower costs for the OECD high user, given a 24 month contract duration and no interest rates[2].

Table 1: Example for the Apple iPhone 4 (16 GB), prices are given in Euro

Operator	T-Mobile and Vodafone		o2	
Tariff	Complete M. L SuperFlat I.	Complete M. XL SuperFlat I. Allnet	o2 Blue 100/250	o2 o + Int. L
Voice				
subscription fee	59.95 €	99.95 €	20/35 €	[15,65] €
incl. minutes national	120 (also EU)	120	100/250	
to fixed networks	free	free	0.29 €	0.15 €
on-net	free	free	free	0.15 €
off-net	0.29 €	free	0.29 €	0.15 €
SMS				
incl. SMS national	40	3000	free	0.15 €
incl. SMS on-net	free		free	0.15 €
further SMS national	0.19 €	0.19 €	free	0.15 €
Mobile device				
iPhone 4 (16 GB)	99.95 €	1.00 €	649 € or 49 € + 25 €/month	

Source: T-Mobile (2010), Vodafone (2010) and o2 (2010)

Based on marketing science and behavioral economics, we know that many consumers in mobile telecommunications choose calling plans that are not always cost minimizing (e.g. Lambrecht and Skiera 2006; Bolle and Heimel 2005). In our paper, we examine how consumers decide between mobile phone tariffs with different contract components. Therefore, we run an experiment with 87 members of the Heinrich-Heine University and test for preferences in selecting mobile phone contracts. Abstracting from demand uncertainty and preferences regarding service quality, images of operators and network externalities, our focus lies on the choice between contracts with and without handset subsidies.

Our paper is organized as follows: The next section 2 provides an overview of the theoretical background and we derive five testable hypothesis. Section 3 explains our experimental design and procedure. Chapter 4 summarizes our descriptive and empirical results. Finally, section 5 concludes and provides policy implications.

[2]See Appendix.

2 Literature and Hypothesis

According to traditional economic theory, consumers are assumed to be rational utility maximizers. However, various articles in the field of behavioral economics show that consumers take irrational decisions, violating the expected utility hypothesis. The theory of bounded rationality, such as in the versions of Simon (1957), Kahneman and Tversky (1979) and Gigerenzer and Selten (2002), incorporates psychological research into economic theory. It introduces several important concepts in the environment of choices under risk, e.g. loss aversion and the shape of the probability weighting function.

In a telecommunication setup, certain aspects of irrational behavior are of interest. In order to detect the right calling plan and maximize the expected utility, consumers have to be aware of their actual and future consumption. Several authors, like Mitchell and Vogelsang (1991), Taylor (1994) and Nunes (2000), state that consumers are not aware of their actual consumption and quite inaccurate in predicting their future usage. Based on these findings, we derive hypothesis H_1 as potential reason for irrational tariff choices:

H_1: Consumers are incapable of estimating their actual average consumption correctly.

Facing a tariff decision, consumers are confronted with a considerable number of alternatives, comprising many different parameters. In our setup, the number of relevant parameters is reduced to three. Nevertheless, participants could still face difficulties due to lacking mathematical abilities. Even if consumers have the ability to analytically derive the optimal tariff, they might still not be willing to do so. Morwitz et al. (1998) and Hossain and Morgan (2006) test whether consumers account for total costs, including e.g. costs for shipping and handling, or just stick to the base price. They find that consumers are often not motivated to perform these calculations properly and hence make wrong decisions. In our setup, this implies that participants possibly do not account for all parameters. Both arguments are summarized in H_2:

H_2: Consumers are unable and/or unwilling to perform the calculations needed to find the cost-minimizing tariff.

Additionally, consumers may find it hard to cope with telecommunication specific aspects, respectively a mobile phone bill. Especially, not all mobile phone subscribers are familiar with the interpretation of billing increments. This ability is tested by H_3:

H_3: Consumers face difficulties analyzing a mobile phone bill.

Selecting tariffs, consumers' usage level plays a decisive role for their performance. If consumption is low, the cost differences between optimal and non-optimal tariffs are relatively small. According to Clay et al. (1992) and Srinagesh (1992), especially these minor cost differences induce a careless behavior of the consumers. This is also proved

by Miravete (2003) who finds that households with lower consumption perform worse than those with higher usage. With H_4, we verify if these results are also true in our experimental setup.

H_4: Low volume users are more likely to opt for cost-dominated tariffs than high volume users.

In addition to these more general causes for irrational choices, our paper investigates consumers' preferences for different payment forms including deferred payments. So far, various articles have been published, dealing with irrational behavior in the telecommunication context. One strand of literature covers consumers' choice between flat rate tariffs and pay-per-use tariffs. Lambrecht and Skiera (2006), Gerpott (2009) and Mitomo et al. (2009) detect in their experiments a sustainable flat-rate bias, leading to consumers choosing flat rate tariffs even though pay-per-use tariffs would yield lower invoices. Bolle and Heimel (2005) and Haucap and Heimeshoff (2011) check for irrational decisions in the context of on-net and off-net calls and Krämer and Wiewiorra (2010) do research on mobile phone tariffs with cost caps. In line with these papers, we assume consumers to hold preferences in favor of different payment forms. These considerations are crucial in our model in which total costs are the only decision parameter. Hence, any deviation from the calling plan with the lowest overall expenditures can be classified as irrational choice, leading to H_5:

H_5: Strong preferences for handset subsidies deter consumers from selecting the tariff with the lowest total costs.

Although various aspects of mobile tariffs have already been studied, as far as we know tariff choice in the context of subsidies has not been analyzed. The next section explains our experimental design and procedure.

3 Empirical Specification

3.1 Experimental Design

Our experiment[3] is structured in three distinctive parts. In the first part, respondents are asked to estimate their average monthly consumption in terms of outgoing minutes. This estimation is compared to the average usage of their last three mobile phone bills. If the participants estimate their consumption correctly, meaning within a range of $\pm 20\%$, they receive an extra payment of 1000 taler.[4]

The second part of the experiment consists of 10 tariff choices. Participants are randomly assigned to the groups A, B, C and D, which are almost equally large. They are incentivized to take cost-minimizing decisions as they are equipped with a certain

[3] See Appendix for further information.

[4] 1000 taler $\hat{=}$ 1 Euro.

amount of money,[5] which is consequently reduced by the costs for the tariffs they choose.

To control for different billing formats[6], the 10 choices are subdivided into two rounds of five choices each. In round 1, participants are told to assume a particular average of monthly outgoing minutes (either 25 min., or 70 min., or 120 min., or 200 min.)[7] and take it as given throughout the next five decisions (choices 1 to 5). The second five questions (choices 6 to 10) are composed in the same way as the first five questions. But in the second round participants have to calculate their average monthly outgoing minutes themselves. A fictional mobile phone bill is handed out and participants are told to take it as representative for their monthly consumption during the choices 6 to 10. The fictional bills are arranged to again display either a 25 min., 70 min., 120 min., or 200 min. monthly usage. Those participants who base their choices on 25 min. in the first round, are confronted with a mobile phone bill of 120 min. in the second round and vice versa. Those who start with a 70 min. (200 min.) usage in round 1, receive a 200 min. (70 min.) bill in the second choice scenario, respectively. Figure 2 illustrates the design of our experiment.

Figure 2: Design of the Experiment

Group	Choices									
	Round 1					Round 2				
	1	2	3	4	5	6	7	8	9	10
A	25 min.					120 min.				
B	70 min.					200 min.				
C	120 min.					25 min.				
D	200 min.					70 min.				

Based on the usage, participants are asked to select their optimal tariff out of three given tariffs (T1, T2 and T3). All three tariffs include an identical mobile device and run for 24 months. Each tariff comprises a price for the handset, a monthly subscription fee and a charge per minute for outgoing calls, irrespective of calling on-net or off-net (i.e. fixed line and other mobile networks). All 10 choices are of the following representative form:

Decision: As your former mobile phone contract has run out of contract, you have the chance to choose between the following mobile phone tariffs:

[5]Group A & C receive 19000 taler and group B & D receive 24000 taler, respectively. The endowments differ to ensure that, irrespective of the group, participants may achieve identical earings.

[6]Usually, mobile operators only list the outgoing calls and minutes in the mobile bill, but some also provide the total amount of outgoing minutes.

[7]By the end of 2009, the with market shares weighted average of outgoing mobile minutes per subscriber was 124 minutes/month in Germany (Merrill Lynch 2010). Therefore, our four groups represent realistic cases for low, medium and high mobile usage.

T1: Price for the mobile phone = 0 taler, monthly subscription fee = 10 taler, price per minute for outgoing calls = 0.6 taler.

T2: Price for the mobile phone = 120 taler, monthly subscription fee = 10 taler, price per minute for outgoing calls = 0.3 taler.

T3: Price for the mobile phone = 0 taler, monthly subscription fee = 15 taler, price per minute for outgoing calls = 0.3 taler.

The setup of our experiment is explained in the following table 2. Part 2 explains the composition of the 5 different questions (choice 1-5 and 6-10, respectively). The first two decisions of each round test participants' logical understanding of the experiment and intend to familiarize them with our experimental design. The other three scenarios control for respondents' tariff preferences regarding different handset payment options.

Table 2: Experimental Setup

Part 1	Estimation of average monthly consumption	
Part 2	Tariff choices	
	Choice 1(6) & Choice 2(7)	Choice 3(8)
T1 T2 T3	Logical understanding & familiarization with experimental design	Handset subsidy Buy now option Hire-purchase option (no mark-up)
	Choice 4 (9)	Choice 5(10)
T1 T2 T3	Handset subsidy Hire-purchase option (no mark-up) Buy now option	Handset subsidy Hire-purchase option (with mark-up) Buy now option
Part 3	Questionnaire on personal characteristics	

In the third part, participants are asked to give detailed information on personal characteristics (age, gender, course of studies etc.) and their calling behavior (prepaid contract, provider changes etc.). The final question tests which tariff they have chosen if they were indifferent between two or three options (being listed first, lowest monthly subscription fee etc.). The following subsection explains our experimental procedure.

3.2 Experimental Procedure

We invited a total of 87 students and staff members of the Heinrich-Heine-University Duesseldorf via Orsee to our experiment. Participants were ask to bring their last three mobile phone bills for which they received three Euro extra. 27 of the 87 participants brought the requested bills along. However, 31 respondents were prepaid customers and thus do not receive monthly bills at all.

Table 3: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
age	87	25.59	7.94	18	56
semester	81	4.65	4.18	1	23
female	87	0.52	0.5	0	1
estimated consumption	87	264.76	519.35	3	3000
real consumption	27	150.86	198.94	3	701
prepaid	87	0.36	0.48	0	1
switched	87	0.36	0.48	0	1
econ	87	0.18	0.39	0	1
group_{AC}	87	0.47	0.50	0	1
Network Operator					
T-Mobile	87	0.14	0.35	0	1
Vodafone	87	0.2	0.4	0	1
E-plus	87	0.38	0.49	0	1
o2	87	0.29	0.46	0	1
Mobile Internet Usage					
never	87	0.68	0.47	0	1
rarely	87	0.06	0.23	0	1
sometimes	87	0.09	0.29	0	1
regularly	87	0.17	0.38	0	1
Satisfaction with provider					
very pleased	87	0.21	0.41	0	1
pleased	87	0.57	0.50	0	1
less pleased	87	0.15	0.36	0	1
discontent	87	0.05	0.21	0	1

The descriptive statistics are summarized in table 3. All respondents (52% female) use mobile telephony, with an average age of 25.6 years. The market shares of the providers E-Plus (38%), o2 (29%), Vodafone (20%) and T-Mobile (14%) differ from the real market situation in Germany, where T-Mobile and Vodafone hold 36.3% and 32.1% of the market share, respectively. In addition, E-Plus and o2 serve 17.3% and 14.2% of all customers (Bundesnetzagentur, 2009). The differences in the operators' market shares can be explained by the fact that the participants were mostly students who are more likely E-net[8] customers due to lower price offers. 78% of the participants are very satisfied or satisfied with their provider, but 36% of our respondents have switched their provider within the last two years. This churn rate is compared to the findings of a study on consumers' switching behavior (EU Commission 2009) relatively

[8]E-Plus and o2 operate in the frequency range of 1800 MHz (E-net), whereas T-Mobile and Vodafone use the frequency range of 900 MHz (D-net).

high. Our descriptive and empirical results are discussed in the next section 4.

4 Results

4.1 Descriptive Results

First, we investigate the degree to which the participants in our sample know their average monthly consumption in terms of outgoing minutes. In line with H_1, we find that about 81.5% of the participants do not estimate their actual usage correctly. Approximately 60% of them have overestimated their average use. Another interesting fact is that the average prediction error is 320 min. for the respondents who overestimated and only 170 min. for the participants who unterestimated their real consumption. This indicates that the prediction bias is almost twice as large in the overconfident group. Hence, it is likely that consumers do not choose cost-minimizing tariffs, leading to systematic errors. These findings are in line with the growing literature related to flat-rate biases (e.g. Lambrecht and Skiera 2006; Gerpott 2009).

Finding the cost-minimizing mobile phone tariff involves some sort of calculations. Based on the questions testing their ability/willingness to perform the calculations correctly, H_2 has to be rejected. In our data set only two out of 87 participants repeatedly select cost dominated tariffs in questions targeting the logical understanding of the experiment (choice 1, 2, 6 and 7). Additionally, from our final question regarding indifferences between different payment forms, we infer that just 2.3% of the respondents choose tariffs because they are listed first. We conclude that non-optimal choices are not caused by lacking understanding/motivation but by biased preferences. However, we offer the participants very stylized forms of mobile phone tariffs, containing only three variables. In reality, consumers are confronted with a lot more criteria including e.g. different prices for on-net and off-net calls and prices for text messages. Therefore, the increasing complexity might however support H_2.

H_3 suggests that participants face difficulties analyzing a mobile phone bill. In order to test H_3, we compare the answers given in the first round for a specific usage (25, 70, 120 or 200 min.) to the choices in the second round. The two rounds just differ in the format the average monthly consumption is presented. In the first round it is given, in the second round participants have to perform calculations themselves. By applying a two-sample Kolmogorov-Smirnov test[9] for all corresponding questions and groups, we cannot reject the null hypothesis, stating that the distributions are equal. We conclude that there are no differences in the distributions between the first and

[9] A two-sample K-S test tests for the equality of distributions between two groups. The distribution of each choice for group A (B) is compared with that of the group C (D), respectively. For example, we first merge the results of question 3 for group A with the results of question 8 of group C both including a usage of 25 min./month. Subsequently, we determine if there are any differences in the distribution between group A and C (for further information see Büning and Trenkler 1994). All K-S tests are summarized in Table 9 in the Appendix.

the second round for any usage type. Hence, H_3 has to be rejected, indicating that respondents are able to interpret a representative monthly bill.

Based on the results stated above, we match all groups with the same average of monthly consumption, irrespective of the two rounds. For example, the results of questions 1 to 5 of group A are combined with the answers to questions 6 to 10 of group C. This process reduces the number of choices to five, labeled $1^* - 5^*$. Figure 3 illustrates the reduced setup.

Figure 3: Reduced Setup

	Choices				
Group	**1***	**2***	**3***	**4***	**5***
A + C			**25 min.**		
B + D			**70 min.**		
C + A			**120 min.**		
D + B			**200 min.**		

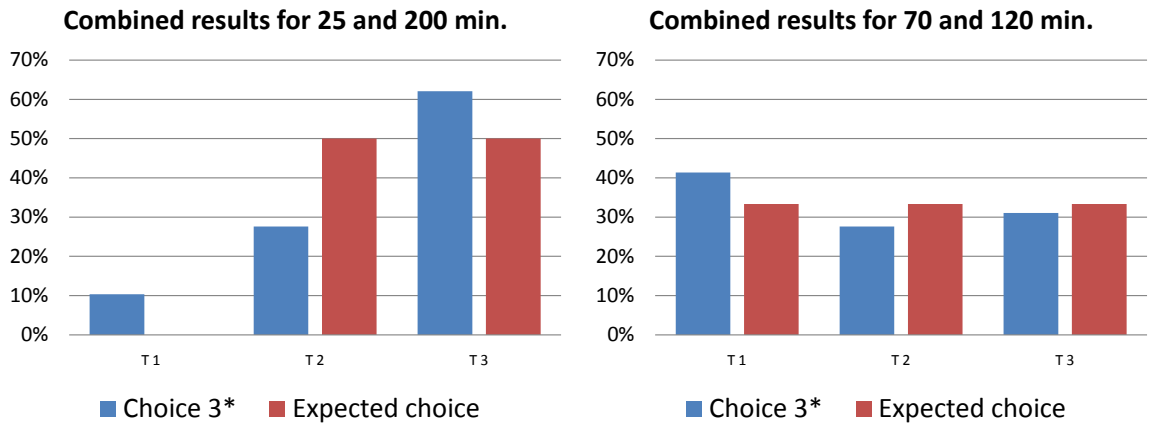
H_4 assumes differences in the performance between low and high volume users. The main explanation is that higher consumption increases the cost differences between optimal and non-optimal tariffs. Hence, high volume users have in general stronger incentives to subscribe to the cost-optimal tariff. In our experiment, every respondent makes on average 0.95 mistakes answering the 10 questions. The participants of group A and C give wrong answers in 10.5% of all questions, whereas the respondents of group B and D fail in 8.7% of all choices. These first results support H_4, as the total usage of group A and C is lower than for group B and D. For an in depth investigation, we compare the average error for the lowest and the highest assumed usage based on the reduced setup. For 25 min., the average error rate is 5.9% compared to 4.3% for a 200 min. usage. Despite of higher error rates, lowest volume users spend on average just 67.3 taler too much compared to 117.9 taler for maximum volume users. We conclude that in line with H_4, high users are disciplined and more likely to opt for the cost-minimizing tariff.

As already mentioned above, mobile phone tariffs in our experiment constitute of and vary in the following cost components: monthly subscription fees, usage-dependent prices and handset payments. H_5 states that consumers have strong preferences for specific mobile phone tariffs. In general, three different tariff concepts can be distinguished. Consumers can choose between tariffs including a buy now option, a hire-purchase alternative or a handset subsidy. Consumers may either purchase the handset immediately at contract formation (buy now option) or pay the handset price by monthly installments (hire-purchase option). For these two varieties all other tariff components are identical, except for the monthly fixed costs. Contracts with handset

subsidies contain no or low expenditures for the handset, as they are included in the relatively higher cost of usage. Preferences for some tariff forms are tested by question 3*, 4* and 5*.

First, we look at choice 3* with the possible choices: tariff with a handset subsidy (T1), a buy now option (T2) and a hire-purchase option with zero interest rate (T3). In case of 25 min. or 200 min. average monthly usage, the tariffs T2 and T3 both minimize costs. Thus, we would expect the two options to be chosen equally often. For 70 min. or 120 min. consumption, the tariffs T1, T2 and T3 yield equal payments and an evenly distribution between the three tariff forms would be likely. Based on identical rational options the results for 25 min. and 200 min., and 70 min. and 120 min. are grouped and compared to the expected, cost-minimizing tariff choices.

Figure 4: Choice 3* - Realized Choices differ from Expected Choices



The left side of figure 4, showing the results for the 25 min. and 200 min. usage, highlights two different aspects. Comparing the two cost-minimizing choices, rational participants seem to prefer the hire-purchase option (T3) over the buy now option (T2). In our experiment, they possess enough money to select both alternatives, however respondents might have in mind their real financial background, leading to the preferences for the hire-purchase option. The second insight is that even though the alternative T1 (handset subsidy) is dominated, it is chosen by about 10%. This indicates a quite strong bias of some participants towards the cost-dominated tariff T1 including a handset subsidy. Looking at the usage types separately, we find that 15% in the 25 min. and only 6.5% in the 200 min. usage group select the more expensive T1. This again supports somehow H_4.

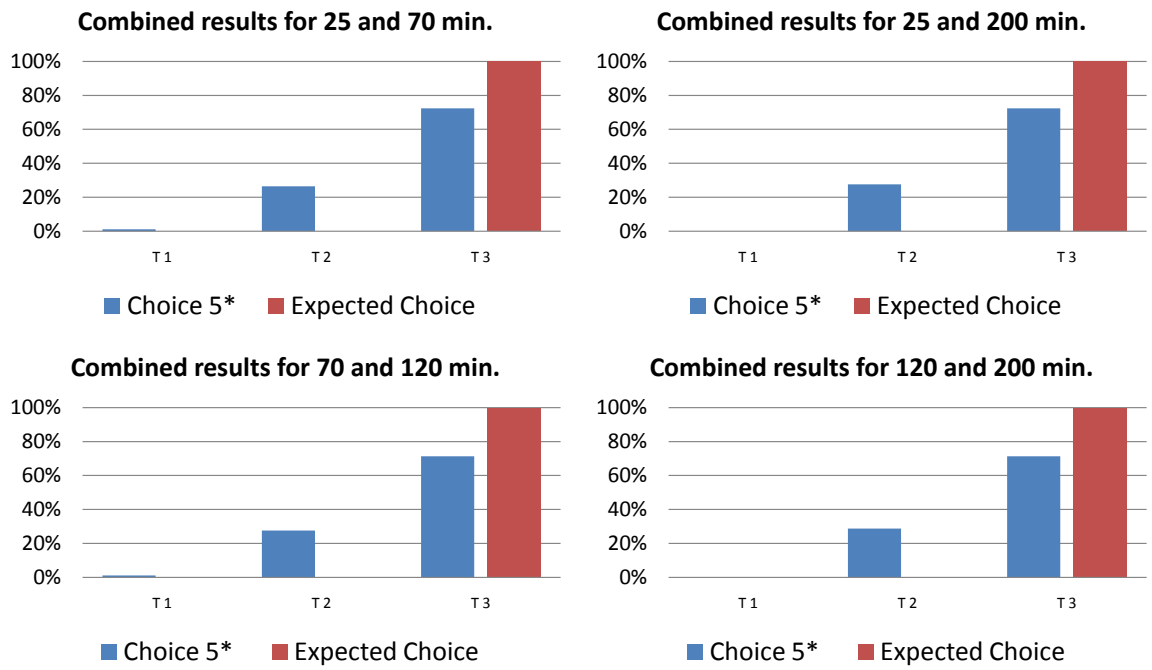
The preference for subsidies is also confirmed by the results presented on the right side of figure 4. Although all three tariffs are rational in this setup, the distribution of the given answers differs from the expected one. It is shifted in favor of the handset subsidy tariff.

Applying chi-square goodness of fit tests[10], we find that the observed choices are significantly different (p-value = 0.0007) from the expected ones for the 25 min. and 200 min. usage. In contrast, for 70 min. and 120 min., the null hypothesis that each option is chosen equally often can not be rejected (p-value = 0.2605).

Question 4* is constructed similarly to question 3*, but on a higher cost level. We find identical choice patterns. But with increasing tariff cost, even more participants tend to prefer the option with a handset subsidy, yielding lower down payments.

In question 5* we have introduced higher costs for the hire-purchase option in comparison to the buy now option. Additionally, we have rearranged the tariff choices to avoid habituation effects. Participants can choose between a tariff with a handset subsidy (T1), a hire-purchase option with a positive mark-up (T2) and a buy now option (T3). The buy now option dominates in all usage groups. Figure 5 illustrates our results. We find that in all possible usage combinations about 30% of the participants prefer the hire-purchase option over the direct purchase, even if they incur a 1% loss due to higher costs. Applying once more chi-square goodness of fit tests for all usage combinations, we find that in all cases the observed choices are significantly different from the expected ones, all on a 5% significance level or higher.

Figure 5: Choice 5* - Realized Choices differ from Expected Choices



Compared to the results of question 3* for 25 min. and 200 min. usage, the handset

[10] A chi-square goodness of fit test tests whether observed percentages for a categorical variable are significantly different from expected percentages. For further information see Büning and Trenkler 1994.

subsidy option is no longer chosen. Being in group 25 min. (200 min.) and selecting the handset subsidy tariff causes additional costs of 60 taler (840 taler) in question 3* and 360 taler (1200 taler) in question 5*. Consequently, consumers hold preferences for the handset subsidy option (T1), but do not realize them if they are too costly. The same holds true for the preferences for the hire-purchase option over the direct purchase. But relatively low cost differences and thus occurred losses in question 5* do not prevent them from choosing this option. Summing it up: Consumers are biased in favor of the handset subsidy and the hire-purchase option but only up to an individual limit. If costs for the preferred variety exceed this certain threshold, consumers select the cost-minimizing tariff.

If we look separately at the different usage types, we find again that low user are more likely to choose non-minimizing tariffs due to smaller costs differences than high users. These results show again evidence in favor of H_4.

In the next section 4.2, we empirically analyze the tariff selection in more detail. We want to investigate which characteristics influence the likelihood of rational behavior by applying probit and logit regressions.

4.2 Estimation Results

In this subsection, we focus on questions 3* and 5*. From question 3* we aim to empirically explore which factors drive the probability of choosing the the hire-purchase option over the direct purchase if the two options are equally expensive. With question 5* we investigate which factors influence the probability of choosing the cost-minimizing buy now option.

First, we look at choice 3* in more detail. As explained above, we can only compare the variants 25 min. and 200 min. and variants 70 min. and 120 min. due to differing optimal answers. For 25 min. and 200 min., T2 and T3 are optimal. As presented in figure 4, the hire-purchase option (T3) seems to be preferred over the direct purchase of the handset (T2). Therefore, we wish to determine which characteristics influence the likelihood of selecting the hire-purchase option, taking only the rational consumers into considerations. Our explanatory variables contain information on age and the time needed to take a decision. In addition, we include dummies to control for personal characteristics. We distinguish whether a person is female ($female$), a prepaid customer ($prepaid$), an economics student ($econ$), a frequent mobile Internet user ($mob_{inthigh}$), a E-net customer ($enet$), satisfied with her net provider ($satisfied_{high}$), and if she has switched the provider within the last two years ($switched$). Furthermore, we include a group dummy equal to 1 if a respondent is in group A or C. Here, $group_{AC}$ indicates a 25 min. usage. Our results are presented in table 4[11].

As we drop all irrational choices, our observations reduce to 76. Focusing on the probit regression, we find that our discrete variables $female$ and $econ$ both have a

[11] A detailed description of all relevant variables can be found in Table 6 in the Appendix.

Table 4: Choice 3* for 25 min. and 200 min.

Variable	Probit	Logit
Dep. Var.	Hire-purchase option	
age	0.0042	0.0034
	(0.0077)	(0.0082)
$time$	0.0001	0.0002
	(0.0008)	(0.0008)
$female$	0.1969*	0.2053*
	(0.1175)	(0.1182)
$prepaid$	-0.1732	-0.1896
	(0.1362)	(0.1501)
$econ$	0.1978*	0.1811*
	(0.1092)	(0.1111)
$mob_{inthigh}$	-0.2360	-0.2534
	(0.1526)	(0.1702)
$enet$	-0.0009	-0.0126
	(0.1241)	(0.1320)
$satisfied_{high}$	-0.0352	-0.0451
	(0.1684)	(0.1729)
$switched$	0.1210	0.1081
	(0.1084)	(0.1117)
$groupAC$	-0.2259*	-0.2345*
	(0.1195)	(0.1293)
N	76	76
Pseudo R^2	0.1357	0.1354

$*,**,***$ indicate statistically significant on the 10%-, 5%-, and 1%-level
Results are already transformed to marginal effects
Heteroscedasticity robust standard errors in parenthesis

significant and positive influence on the likelihood of choosing the hire-purchase option. Furthermore, $group_{AC}$ has a significant, but negative effect. As we have reported marginal effects in table 3 for the probit regression, we can directly interpret these effects: The probability of selecting the hire-purchase option is 0.1969 higher if a subject is $female$. Additionally, the probability of choosing T3 increases by 0.1978, if the person studies economics or business administration. Although there is no monetary difference between the two tariffs in our experiment, this might be explained by the discounting theory learned during the first semesters. For those participants who assume a 25 min. usage, the likelihood of selecting the hire-purchase option is reduced by 0.2259. Our results are robust applying logit regression. Around 13.5% of the total variation is explained by our model. A drawback is that all three variables are only

significant on a 10% significance level.

Analyzing choice 3* for the variants 70 min. and 120 min., we do not find any significant effects indicating which variables determine the preferences for a specific tariff option. This is not very surprising, as we already see in figure 4 that the variation between the three tariff options is low due to identical costs.

In addition, we examine choice 5*, where we have included a make-up of about 1% for the hire-purchase option over the direct purchase. In this setup, it is rational to choose the buy now option for all given usage types. Table 5 summarizes our empirical results for the representative 25 min. and 200 min. usage.[12]

Table 5: Choice 5* for 25 min. and 200 min.

Variable	Probit	Logit
Dep. Var.	Buy now option	
age	-0.0239***	-0.0223***
	(0.0066)	(0.0068)
time	0.0039***	0.0036**
	(0.0013)	(0.0015)
female	-0.1311	-0.1305
	(0.0964)	(0.0971)
prepaid	-0.0747	-0.0690
	(0.1044)	(0.1022)
econ	0.0570	0.0432
	(0.1134)	(0.1128)
$mob_{inthigh}$	-0.0357	-0.0215
	(0.1147)	(0.1113)
enet	-0.2377***	-0.2366***
	(0.0900)	(0.0943)
$satisfied_{high}$	0.3498**	0.3595**
	(0.1594)	(0.1666)
switched	0.0350	0.0259
	(0.0969)	(0.0988)
groupAC	0.0054	0.0099
	(0.1022)	(0.1029)
N	85	85
Pseudo R^2	0.2840	0.2779

$*, **, ***$ indicate statistically significant on the 10%-, 5%-, and 1%-level
Results are already transformed to marginal effects
Heteroscedasticity robust standard errors in parenthesis

[12]The probit estimations for all other possible usage combinations can be found in Table 7 in the Appendix.

Regarding the probit regression, the variables *age* and *enet* both have a negative, but highly significant effect on the likelihood of choosing the direct purchase option. While *time* and $satisfied_{high}$ both have a positive influence on a 5% significance level or higher. The probability of selecting the direct purchase option decreases by 0.0239 per year of age. Being an E-net customer reduces the likelihood of choosing T3 by 0.2377. The reason might be that price-sensitive E-net customers are deterred by the high direct payment of T3. Those participants who take more time to make a decision are more likely to opt for the rational tariff, although the magnitude is with 0.0039 rather small. Being satisfied with their mobile operator increases the probability of selecting T3 by 0.3498. Moreover, 28.4% of the total variation is explained by our model.

All aspects considered, the findings suggest that some individual factors shape mobile phone tariff choice. In the final section, we summarize our results and discuss resulting policy implications.

5 Conclusion and Policy Implications

Our paper has analyzed different sources for potential biases in consumers' mobile tariff choices. We detect that consumers are often not aware of their average monthly consumption in terms of outgoing minutes. Recent developments have compounded this problem. According to § 99 of the German Telecommunications Act (TKG), network operators are allowed, but not obliged, to list all outgoing calls covered by a voice flat rate. Recently, some network operators do no longer publish all calls placed within a flat rate. Thus, consumers may be unable to verify their individual consumption on the basis of their mobile phone bill. Contrary to the argumentation of the network operators and the Federal Network Agency, we believe that the existing regulation harms consumers, making it even more difficult for them to find out their monthly consumption.

Being confronted with mobile phone tariffs, consumers are able to interpret different components. In principle, they know how to find cost-minimizing tariffs. This is also true if the consumption is based on stylized mobile phone bills. However, in reality mobile phone tariffs are often presented in a rather different way than in our experiment. Consumers have to extract all relevant information from the Internet or from brochures for innumerably many tariffs. Additionally, the number of relevant parameters is typically not limited to three. This makes is a lot more difficult for the consumers to come up with the optimal tariff.

In our setup, we find that high users perform better than respondents with lower consumption levels. Due to larger cost differences between optimal and non-optimal tariffs, high users are disciplined and more likely to opt for the cost-minimizing tariff.

Besides, consumers seem to have preferences for certain tariff forms, possibly deterring them from selecting cost-minimizing tariffs. We have shown that consumers

hold preferences for subsidies and hire-purchases of mobile devices. In one of our setups, about 10% select the cost-dominated handset subsidy, indicating a stong bias. And among the two rational payment options for the handset (direct purchase and the hire-purchase), participants clearly prefer the second possibility.

These findings are also confirmed in a second setup, where around 28% of the participants opt for the more expensive hire-purchase tariff. We infer that the likelihood of choosing the cost-minimizing direct purchase increases if participants are satisfied customers and with the time taken for making a decision. In addition, we find that the probability decreases with age and if a participant is an E-net customer.

Our insights are also of special interest for the mobile operators, as they can easily profit from consumers preferences. In fact, operators seem to exploit existing biases. For example, T-Mobile and Vodafone continue to subsidize mobile devices, whereas o2 offers the direct purchase or the hire-purchase of the iPhone. Within o2 tariffs, the hire-purchase option includes no interest payments compared to the direct purchase. However, it is also possible to buy the iPhone directly via the Apple store where it is up to 8% less expensive compared to the o2 offers. This induces that o2 introduces hidden interest rates for the hire-purchase option. Still, consumers could prefer purchasing via the operators. Transaction costs might be one explanation, biased preferences for hire-purchases as we found it in our experiment another.

We have merely presented a first step into the investigation of consumers' preferences for different handset payment forms. While our study has focused on certain special reasons for irrational tariff choices, there may be many more aspects left to analyze. Especially, the flat-rate bias has to be mentioned and kept in mind for a complete analysis. Further work should especially consider potential bias from increasing tariff complexity and the effects of network externalities.

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6 Appendix

We use the assumptions (table 6) of the OECD high usage type (OECD 2009) to calculate average costs of the different tariffs presented in table 1 given a 24 month contract duration.[13] Assuming away interest rates, the present value of the two year contracts Complete Mobile XL (T-Mobile) or SuperFlat Internet Allnet(Vodafone) is 2399.80 Euro, whereas the o2 tariff o2 o plus Internet L costs only 2092.60 Euro over the period of 24 month.

Table 6: OECD High User Type, Usage per year and its distribution

	Distribution			
Components	Fixed	Mobile on-net	Mobile off-net	Voicemail
246 outgoing call minutes	20%	47%	26%	7%
55 SMS		65%	35%	
1 MMS				

Source: OECD (2009)

Information on the experiment[14]

Welcome to this decision experiment regarding mobile phone tariffs.

Please read the instructions carefully. The entire experiment is anonymous. Throughout the experiment you - as a participant - take the role of a consumer with a given consumption, choosing between different fictitious mobile phone tariffs. In the first round, you will be given a precise number of minutes which you use per month. This value is crucial for the choice of tariff. In the second round, you have to calculate your monthly consumption based upon a fictitious representative invoice in order to find the optimal tariff. All mobile phone contracts include the following terms:

1. A contract period of 24 months.
2. No cancellation ahead of contract termination.
3. Billing increment 60/60 (i.e. every inchoate minutes is counted completely).

Ten decisions are to be made in this experiment in total. Interest rates are not taken into account in this experiment. As supporting tools you may use a pencil, paper and

[13] Voicemail will be credit 50:50 on-net and off-net

[14] This are the instructions group A and C received. The instructions for group B and D only differ in the basic amount of 24000 talers instead of 19000 talers.

a calculator. A calculator tool can be found at the bottom left of your screen as soon as the experiment starts.

During the experiment you can earn talers depending on your decisions. At the end of the experiment, the gained talers are exchanged at a rate of 1000 talers = 1 Euro and paid out to you. To do so, please wait in your booth until you are called to collect your payment. Please bring all your documents, which you got from us, to the payout after the experiment. You start with a basic amount of 19000 talers (19 Euro). This amount is downsized by your expenses.

The costs of the chosen tariff are drawn off your starting amount after each decision. Please note: Exactly one tariff must be chosen under any circumstance. In case no tariff has been chosen, the worst tariff is selected for you. You are able to minimize your expenses by your own decision.

Additionally to the experiment, you can earn further 1000 talers by estimating correctly your personal consumption within a range of ±20%.

Please note that from now on and during the entire experiment, you must not talk to any other participant. We are forced to call off the experiment, should it happen. Please switch off your mobile phones and turn it back on not until the experiment has ended. If there are any questions, please raise your hand and we will come to you.

Instruction[15]

Welcome to this decision experiment regarding mobile phone tariffs

Please indicate your average mobile phone usage in terms of outgoing minutes per month: My consumption is about _____ outgoing minutes per month.

Round 1

An analysis of your telephony characteristics has shown, that you call with your mobile phone 25 minutes a month. The following tariffs apply to the identical mobile phone of company X. Decisions 1 - 5 are independent of each other. Please choose exactly one tariff.

Decision 1: As your former mobile phone contract has run out of contract, you have the chance to choose between the following mobile phone tariffs.

T1: Price for the mobile phone: = 0 talers, monthly subscription fee = 10 talers, price per minute for outgoing calls = 0.3 talers.

T2: Price for the mobile phone: = 0 talers, monthly subscription fee = 10 talers, price per minute for outgoing calls = 1 taler.

[15]This is the instruction group A received. The instructions for group B, C and D display the corresponding averages of monthly outgoing minutes.

T3: Price for the mobile phone: = 0 talers, monthly subscription fee = 10 talers, price per minute for outgoing calls = 0.07 talers.

Decision 2: As your former mobile phone contract has run out of contract, you have the chance to chose between the following mobile phone tariffs.

T1: Price for the mobile phone: = 50 talers, monthly subscription fee = 10 talers, price per minute for outgoing calls = 0.18 talers.

T2: Price for the mobile phone: = 50 talers, monthly subscription fee = 7 talers, price per minute for outgoing calls = 0.3 talers.

T3: Price for the mobile phone: = 50 talers, monthly subscription fee = 12 talers, price per minute for outgoing calls = 0.1 talers.

Decision 3: As your former mobile phone contract has run out of contract, you have the chance to chose between the following mobile phone tariffs.

T1: Price for the mobile phone: = 0 talers, monthly subscription fee = 10 talers, price per minute for outgoing calls = 0.6 talers.

T2: Price for the mobile phone: = 120 talers, monthly subscription fee = 10 talers, price per minute for outgoing calls = 0.3 talers.

T3: Price for the mobile phone: = 0 talers, monthly subscription fee = 15 talers, price per minute for outgoing calls = 0.3 talers.

Decision 4: As your former mobile phone contract has run out of contract, you have the chance to chose between the following mobile phone tariffs.

T1: Price for the mobile phone: = 0 talers, monthly subscription fee = 50 talers, price per minute for outgoing calls = 0.5 talers.

T2: Price for the mobile phone: = 0 talers, monthly subscription fee = 77 talers, price per minute for outgoing calls = 0.275 talers.

T3: Price for the mobile phone: = 648 talers, monthly subscription fee = 50 talers, price per minute for outgoing calls = 0.275 talers.

Decision 5: As your former mobile phone contract has run out of contract, you have the chance to chose between the following mobile phone tariffs.

T1: Price for the mobile phone: = 0 talers, monthly subscription fee = 30 talers, price per minute for outgoing calls = 0.5 talers.

T2: Price for the mobile phone: = 0 talers, monthly subscription fee = 20,25 talers, price per minute for outgoing calls = 0.3 talers.

T3: Price for the mobile phone: = 240 talers, monthly subscription fee = 10 talers, price per minute for outgoing calls = 0.3 talers.

Round 2
Two years later your existing contract runs out and you have to choose a new tariff. In your booth, you find a copy of a representative invoice. Determine your consumption and take it as fixed over the next 24 months. The following tariffs apply to the identical mobile phone of company X. Decisions 6 - 10 are independent of each other. Please choose exactly one tariff.

Your mobile phone invoice:

- Invoice date 10/2010
- Billing Increment 60/60
- Mobile phone number: 017xxxxxxxxx
- Total (All numbers in EUR zero - rate VAT) x, xx

Date	Time	Number	Duration
01.10.2010	13:51:40	01604477xxx	00:21:34
04.10.2010	16:32:10	01604477xxx	00:07:49
05.10.2010	18:21:45	01743152xxx	00:04:19
08.10.2010	11:29:10	01743152xxx	00:08:09
09.10.2010	14:58:30	01604477xxx	00:05:48
10.10.2010	11:27:04	01743152xxx	00:03:42
11.10.2010	13:24:00	01693152xxx	00:06:27
13.10.2010	14:57:25	01743152xxx	00:11:20
13.10.2010	14:59:51	01523152xxx	00:02:19
21.10.2010	11:36:13	01743152xxx	00:20:22
27.10.2010	15:41:23	01604477xxx	00:06:16
28.10.2010	22:32:48	01743152xxx	00:02:16
29.10.2010	22:33:57	01743152xxx	00:12:02

Decision 6: With your newly gained insight you now have the chance to choose between the following mobile phone tariffs.

T1: Price for the mobile phone: = 0 talers, monthly subscription fee = 10 talers, price per minute for outgoing calls = 0.3 talers.

T2: Price for the mobile phone: = 0 talers, monthly subscription fee = 10 talers, price per minute for outgoing calls = 1 talers.

T3: Price for the mobile phone: = 0 talers, monthly subscription fee = 10 talers, price per minute for outgoing calls = 0.7 talers.

Decision 7: With your newly gained insight you now have the chance to choose between the following mobile phone tariffs.

T1: Price for the mobile phone: = 50 talers, monthly subscription fee = 10 talers, price per minute for outgoing calls = 0.2 talers.

T2: Price for the mobile phone: = 50 talers, monthly subscription fee = 5 talers, price per minute for outgoing calls = 0.225 talers.

T3: Price for the mobile phone: = 50 talers, monthly subscription fee = 12 talers, price per minute for outgoing calls = 0.19 talers.

Decision 8: With your newly gained insight you now have the chance to choose between the following mobile phone tariffs.

T1: Price for the mobile phone: = 0 talers, monthly subscription fee = 12 talers, price per minute for outgoing calls = 0.325 talers.

T2: Price for the mobile phone: = 120 talers, monthly subscription fee = 10 talers, price per minute for outgoing calls = 0.3 talers.

T3: Price for the mobile phone: = 0 talers, monthly subscription fee = 15 talers, price per minute for outgoing calls = 0.3 talers.

Decision 9: With your newly gained insight you now have the chance to choose between the following mobile phone tariffs.

T1: Price for the mobile phone: = 0 talers, monthly subscription fee = 50 talers, price per minute for outgoing calls = 0,5 talers.

T2: Price for the mobile phone: = 0 talers, monthly subscription fee = 77 talers, price per minute for outgoing calls = 0,275 talers.

T3: Price for the mobile phone: = 648 talers, monthly subscription fee = 50 talers, price per minute for outgoing calls = 0,275 talers.

Decision 10: With your newly gained insight you now have the chance to choose between the following mobile phone tariffs.

T1: Price for the mobile phone: = 0 talers, monthly subscription fee = 30 talers, price per minute for outgoing calls = 0.5 talers.

T2: Price for the mobile phone: = 0 talers, monthly subscription fee = 20,25 talers, price per minute for outgoing calls = 0.3 talers.

T3: Price for the mobile phone: = 240 talers, monthly subscription fee = 10 talers, price per minute for outgoing calls = 0.3 talers.

Round 3 - Concluding Questions
First of all, we ask you to fill in your personal details. These are dealt with confidentially.

- Age:
- Gender:
- Course of studies:
- Semester:
- Network operator:
- Prepaid contract:
  - Yes
  - No
- Mobile Internet Usage
  - Never
  - Rarely
  - Sometimes
  - Regularly
- Satisfaction with your provider:
  - Very pleased
  - Pleased
  - Less pleased
  - Discontent
- Change of provider within the last two years:
  - Yes
  - No

If you felt that two or more tariffs in this experiment were equally good, which criteria did you employ to decide for one tariff?
I chose the tariff, which

- was in the first place.
- had the lowest device price.
- had the lowest basic charge per month.
- lowest price per minute.
- I never perceived two or more tariffs as equally good.

Thank you for participating in this experiment!

Table 7: Summary Statistics

Variable	Description
age	Age of participant
$semester$	Semester of participant
$time$	Time needed to take a single decision
$female$	Dummy = 1 if a participant is female
$prepaid$	Dummy = 1 if a participant is a prepaid customer
$econ$	Dummy = 1 if a participant studies economics or business
$mob_{inthigh}$	Dummy = 1 if a participant uses mobile Internet sometimes or regularly
$enet$	Dummy = 1 if a participant is a E-net customer
$satisfied_{high}$	Dummy = 1 if a participant is satisfied or very satisfied with its provider
$switched$	Dummy = 1 if a participant has switched its provider within the last 2 years
$groupAC$	Dummy = 1 if a participant is in group A or C

Table 8: Choice 5* - for all possible combinations

Variable	$choice5_{25200}$	$choice5_{120200}$	$choice5_{2570}$	$choice5_{70120}$
	Probit			
Dep. Var.	Buy now option			
age	-0.0239***	-0.0242***	-0.0188***	-0.0190***
	(0.0066)	(0.0069)	(0.0065)	(0.0067)
$time$	0.0039***	0.0043***	0.0025*	0.0031*
	(0.0013)	(0.0014)	(0.0015)	(0.0017)
$female$	-0.1311	-0.1173	-0.1746*	-0.1488
	(0.0964)	(0.1040)	(0.1008)	(0.1054)
$prepaid$	-0.0747	0.0993	0.0291	0.1862**
	(0.1044)	(0.0956)	(0.1081)	(0.0956)
$econ$	0.0570	-0.0100	-0.0031	-0.0622
	(0.1134)	(0.1443)	(0.1316)	(0.1496)
$mob_{inthigh}$	-0.0357	0.0307	0.0900	0.1615
	(0.1147)	(0.1223)	(0.1103)	(0.1075)
$enet$	-0.2377***	-0.1953**	-0.1330	-0.0923
	(0.0900)	(0.0999)	(0.1150)	(0.1193)
$satisfied_{high}$	0.3498**	0.3172*	0.1413	0.1239
	(0.1594)	(0.1836)	(0.1607)	(0.1704)
$switched$	0.0350	-0.2018	0.0419	-0.1855*
	(0.0969)	(0.1104)	(0.0989)	(0.1081)
$groupAC$	0.0054	0.0362	-0.0036	0.0342
	(0.1022)	(0.1005)	(0.1066)	(0.1020)
N	85	85	85	85
Pseudo R^2	0.2840	0.2853	0.1540	0.1849

$*,**,***$ indicate statistically significant on the 10%-, 5%-, and 1%-level
Results are already transformed to marginal effects
Heteroscedasticity robust standard errors in parenthesis

Table 9: Two-sample Kolmogorov-Smirnov test for equality of distribution functions for all choices and given usages

Choice 1 - 25 Minutes Usage			
Smaller group	D	P-value	Exact
25	0.0000	1.000	
120	-0.0024	1.000	
Combined K-S	0.0024	1.000	1.000
Choice 2 - 25 Minutes Usage			
Smaller group	D	P-value	Exact
25	0.0405	0.967	
120	-0.0714	0.901	
Combined K-S	0.0714	1.000	1.000
Choice 3 - 25 Minutes Usage			
Smaller group	D	P-value	Exact
25	0.0238	0.988	
120	-0.0071	0.999	
Combined K-S	0.0238	1.000	1.000
Choice 4 - 25 Minutes Usage			
Smaller group	D	P-value	Exact
25	0.0500	0.950	
120	0.0000	1.000	
Combined K-S	0.0500	1.000	1.000
Choice 5 - 25 Minutes Usage			
Smaller group	D	P-value	Exact
25	0.2786	0.204	
120	0.0000	1.000	
Combined K-S	0.2786	0.404	0.306
Choice 1 - 70 Minutes Usage			
Smaller group	D	P-value	Exact
70	0.0000	1.000	
200	0.0000	1.000	
Combined K-S	0.0000	1.000	1.000
Choice 2 - 70 Minutes Usage			
Smaller group	D	P-value	Exact
70	0.0000	1.000	
200	-0.0909	0.827	
Combined K-S	0.0909	1.000	1.000

Choice 3 - 70 Minutes Usage			
Smaller group	D	P-value	Exact
70	0.1174	0.729	
200	0.0000	1.000	
Combined K-S	0.1174	0.997	0.987
Choice 4 - 70 Minutes Usage			
Smaller group	D	P-value	Exact
70	0.0341	0.974	
200	-0.0114	0.997	
Combined K-S	0.0341	1.000	1.000
Choice 5- 70 Minutes Usage			
Smaller group	D	P-value	Exact
70	0.1098	0.758	
200	-0.0417	0.961	
Combined K-S	0.1098	0.999	0.994
Choice 1 - 120 Minutes Usage			
Smaller group	D	P-value	Exact
25	0.0000	1.000	
120	-0.0524	0.945	
Combined K-S	0.0524	1.000	1.000
Choice 2 - 120 Minutes Usage			
Smaller group	D	P-value	Exact
25	0.0500	0.950	
120	-0.1000	0.815	
Combined K-S	0.1000	1.000	1.000
Choice 3 - 120 Minutes Usage			
Smaller group	D	P-value	Exact
25	0.2048	0.424	
120	0.0000	1	
Combined K-S	0.2048	0.784	0.698
Choice 4 - 120 Minutes Usage			
Smaller group	D	P-value	Exact
25	0.2667	0.233	
120	0.0000	1.000	
Combined K-S	0.2667	0.460	0.380
Choice 5 - 120 Minutes Usage			
Smaller group	D	P-value	Exact
25	0.0333	0.977	
120	0.0000	1.000	
Combined K-S	0.0333	1.000	1.000

Choice 1 - 200 Minutes Usage			
Smaller group	D	P-value	Exact
70	0.0000	1.000	
200	-0.0417	0.961	
Combined K-S	0.0417	1.000	1.000
Choice 2 - 200 Minutes Usage			
Smaller group	D	P-value	Exact
70	0.1326	0.668	
200	-0.1212	0.714	
Combined K-S	0.1326	0.988	0.960
Choice 3 - 200 Minutes Usage			
Smaller group	D	P-value	Exact
70	0.1970	0.410	
200	0.0000	1.000	
Combined K-S	0.1970	0.765	0.673
Choice 4 - 200 Minutes Usage			
Smaller group	D	P-value	Exact
70	0.0076	0.999	
200	-0.2045	0.383	
Combined K-S	0.2045	0.723	0.598
Choice 5 - 200 Minutes Usage			
Smaller group	D	P-value	Exact
70	0.0227	0.988	
200	0.0000	1.000	
Combined K-S	0.0227	1.000	1.000

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Heinrich-Heine-University of Düsseldorf

Düsseldorf Institute for Competition Economics (DICE)

Universitätsstraße 1 _ 40225 Düsseldorf
www.dice.uni-duesseldorf.de

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