Consumer Preferences for Improvements in Mobile Telecommunication Services

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ABSTRACT

We employ a choice experiment in order to estimate consumers' willingness to pay for improvements in mobile services, focusing on 4G upgrades and roaming services. The attributes of an improved mobile service that we investigate in our experiment are: increased mobile internet speed (possible with 4G), unlimited mobile internet use, improved quality (possible with 4G) and unrestrained use in two neighbouring countries (unrestrained roaming). The results indicate that people value unrestrained roaming services the most. Increased speed and unlimited use attributes are next, and are similarly significant at the 1% level. The impact of improved quality is statistically insignificant at the 5% level, suggesting that consumers are content with the current level of quality they receive with 3G. We conclude that bilateral roaming regulation between governments is more valuable than 4G investments.

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JEL classification: C5, D12, L96

Research highlights:

- We model the utility consumers derive from improvements in mobile services.
- We estimate the marginal willingness-to-pay for each improvement.
- Consumers will pay 2% of their average monthly income for unrestrained roaming.
- Consumers will pay for improved data rates, but not for improved quality.
- Consumers are indifferent between a 30 Mbps 4G service and a 300 Mbps 4G service.

1. Introduction

Advances in telecommunications have turned the world into a more connected, more 'globalized' place in the 20th century, and have been a major contributor to increased economic efficiency and productivity in every possible sector. Technological progress in telecommunications continues to change the way we live our lives in the 21st century.

Mobile communications (MC) has been the star of telecommunications in the past two decades. Initially MC was a means for speaking and texting over mobile phones using 1G and later GSM (2G) technologies. The introduction of 3G enabled mobile users to connect to the internet and to send and receive various multimedia messages. Then 4G arrived, making it possible to access mobile internet with speeds that even some fixed broadband technologies cannot achieve. The International Mobile Telecommunications Advanced specification sets the peak speed requirements for 4G service at 100 Mbps for high mobility communication and 1 Gbps for low mobility communication (ITU, 2008). Commercial 4G networks have not yet achieved the peak speeds of the specification, although they have spread rapidly around the world since the early 2010s. As of November 2014, there are 331 4G LTE networks offering varying data connection speeds, deployed in 112 countries. The top speeds available are offered by 21 commercial 4G LTE-A CA networks launched in 14 countries, subscribers of which enjoy downlink data speeds ranging from 225 Mbps to 300 Mbps (Ericsson, 2014).

Numerous prior studies have focused on the MC sector. However, rapidly changing technologies continue to open up new territories for academic and empirical research. Previous literature has touched on MC licensing and auctions (Klemperer, 2002; Fuentelsaz et al., 2008), mobile tariff discrimination (Haucap and Heimeshoff, 2011), mobile roaming (Fabrizi and Wertlen, 2008; Stühmeier, 2012), MC adoption (Rice and Katz, 2003; Pagani, 2004; Bouwman et al., 2007), and consumer preferences for MC services (Kim, 2005; Shin et al., 2011; Kwak and Yoo, 2012; Klein and Jakopin, 2014). This paper presents a brand-new study on the last of the subject areas in this list.

We employ a choice experiment (CE) in order to estimate consumer preferences for a selection of 'current and crucial' improvements in MC services. The attributes we evaluate are: increased mobile internet speed, unlimited mobile internet use, improved quality of communications service, and unrestrained use abroad. These service upgrades are missing in most mobile markets around the world, and each one is of interest for a reason.

Although 4G is deployed in many countries, there are still many regions that are not covered, and many more that are covered but lagging behind in terms of 4G technology. Consumers of mobile services in these regions have yet to fully benefit from the features of 4G, namely increased mobile internet speed and improved quality. Therefore, understanding the value of introducing these features continues to be of interest. Unlimited mobile internet use is interesting because most mobile broadband services on offer have data caps, whereas fixed broadband services generally provide unlimited use. Mobile broadband could become a competitor of fixed broadband if offered with unlimited use, so we aim to quantify the value that consumers associate with this attribute. Finally, unrestrained use abroad is of interest because people are travelling more than ever, and operators are charging excessively for roaming mobile services. The EU has taken steps to regulate its roaming market (Salsas and Koboldt, 2004; Shortall, 2010; Infante and Vallejo, 2012), and recently independent countries have started to

make bilateral agreements for coordinated action on roaming services (Singapore and Malaysia in 2011 (The Independent, 2011), Australia and New Zealand in 2013 (MBIE, 2013)). We might expect to see more countries follow suit in the near future, if the value for the consumers is depicted more clearly.

Our aim in this study is to evaluate consumers' willingness to pay (WTP) for the abovementioned attributes, as a measure of their value. We conduct 320 face-to-face interviews with people from all regions of North Cyprus, asking respondents to choose between their existing mobile service and two other hypothetical alternatives with varying attribute levels. We estimate consumers' marginal WTP (MWTP) for each attribute by analysing how they trade off between price and other attributes when making their choices.

North Cyprus is a developing economy in the Eastern Mediterranean with a population slightly below 300,000. Mobile use is spread widely throughout the country and the currently available mobile technology is 3G. The results of this study are useful for the government of North Cyprus in designing a possible auction or tender for 4G licensing, and for mobile network operators in analysing the costs and benefits of future 4G investment. Similarly, these results should be of interest for all developing countries, and especially for Turkey, the 20th largest mobile market in the world in terms of number of subscribers in 2013 (ITU, 2015). Like North Cyprus, Turkey has not yet introduced 4G, and the same operators dominate both the Turkish market and the market in North Cyprus (Turkcell and Vodafone).

The paper is organized as follows. Section 2 reviews the previous research in this area and section 3 explains the methodology used in the study. Section 4 defines the model to be estimated and the estimation results are presented in section 5. Finally, section 6 discusses the results and concludes.

2. Background

Estimating consumer preferences for the attributes of telecommunications services has been a topic of interest among researchers since the advent of broadband internet in the 1990s. Earlier studies focused on fixed broadband services, while the focus has shifted towards mobile services since the 2010s as mobile technologies have caught up and overtaken fixed technologies. A number of notable stated preference studies that estimate consumers' valuations for telecom services and their attributes have been completed to date.

2.1 Consumer studies for fixed broadband services

Madden and Simpson (1997) were among the first to carry out research in this area. They used data obtained from a national survey of households in Australia in order to determine the willingness of households to subscribe to a broadband network. The fact that broadband services were not currently available at that time was a complication for their study. Out of 1,010 households surveyed, 598 provided usable data. The authors employed maximum likelihood estimation for a logit model, and found that the effects of the installation fee and income on the probability of subscription were statistically significant, whereas the effect of monthly fee was not. Other determinants for the probability of subscription were the size of the household, the age of the household head and whether the head was employed in a blue-collar occupation.

Ida and Kuroda (2006) studied the Japanese market for broadband services such as ADSL, CATV (cable television internet) and FTTH (fibre to the home). They employed a discrete choice analysis with a nested logit model on a data set of 1,013 observations. They showed that a nested choice structure of narrowband (dial-up, ISDN) versus broadband (ADSL, CATV, FTTH) is the best model fit because of the sign conditions of price and speed variables, their statistical significance and degrees of fitness. They also showed that the own-price elasticity of ADSL is inelastic, while the figures for CATV and FTTH are elastic, concluding that the ADSL market is independent of other services.

Rosston et al. (2010) produced the most comprehensive CE study on the broadband internet market in the USA, and for the first time introduced the effects of attributes. The authors employed discrete choice analysis to estimate the marginal WTP for improvements in eight internet service characteristics: cost, reliability, speed, laptop mobility, movie rental, priority, telehealth and videophone. The data was from a nationwide survey conducted with 6,271 respondents in late 2009 and early 2010. The results implied that reliability and speed were important characteristics of internet service. Estimated MWTPs were 20 USD per month for more reliable service, 45 USD for an improvement in speed from slow to fast, and 48 USD for an improvement in speed from slow to very fast. MWTPs for the other attributes were 6 USD or less. Valuations for broadband internet were larger for experienced households, and there was an estimated two- to three-fold increase in consumer surplus between 2003, when a similar study was conducted, and 2010.

Carare et al. (2015) focused on measuring the WTP for broadband of non-adopters in the USA. They reported that 28% of American households did not have a broadband subscription as of October 2012, and set out to identify the determinants of broadband adoption. The study used a survey of 15,082 households conducted in 2011. Approximately two thirds of the respondents stated that they would not consider subscribing at any price, for reasons such as a lack of skills or a lack of a computer or other device. The authors found that, conditional on the available household characteristics, including education and the presence of children, the likelihood of broadband adoption increased with higher levels of income.

2.2 Consumer studies for mobile broadband services

The term 'mobile broadband' was born with the advent of 3G technology in the 2000s. Since then, there have been a number of empirical studies evaluating consumer preferences for mobile broadband services, both 3G and 4G, and for related attributes.

Kim (2005) estimated consumer preferences for IMT-2000 (3G) services, focusing on service upgrades including video telephony, global roaming and multimedia mobile internet applications. Using a survey of 250 respondents from Seoul, South Korea, Kim found large variations in consumer valuation of 3G service upgrades. The results indicated that consumers place a higher value on video telephony than on multimedia mobile internet and global roaming services.

Shin et al. (2011) carried out a similar conjoint analysis for mobile service consumption in Uzbekistan. Their primary aim was to identify the demand for mobile number portability (MNP), which refers to consumers' right to keep their mobile numbers while switching between mobile service providers. Other attributes estimated in the study were price, call and service quality, discount calls within the same network, and the mobile network operator company. Using 115 responses for their survey, the authors found that price and quality were the most valuable attributes, while subscribers did not consider MNP to be an important service upgrade.

The first study evaluating consumers' preferences for 4G technology was by Kwak and Yoo (2012). It involved 500 person-to-person interviews held in Seoul, South Korea, in which a CE was used in order to evaluate the MWTP for the following 4G attributes: data rates, quality of communications service, number of broadcasting channels, video-on-demand (VOD) service and supplementary services. The authors found that "consumers were interested in 4G and were quite prepared to pay for 4G services". Estimated per-month figures for MWTP were 4.03 USD for improved communication service, 0.06 USD for an additional broadcasting channel, 1.75 USD for VOD and 1.45 USD for supplementary services.

Klein and Jakopin (2014) took a different approach in their conjoint analysis study, attempting to investigate bundling of mobile telecommunication services. As mobile use has spread and competition in the mobile sector has intensified, mobile operators have aimed to gain competitive edge by bundling services together, including, but not limited to, minutes for talking,

text messaging, internet access, and even financing for a mobile device. The authors collected data via an online survey among German consumers, and carried out their analysis using 116 responses out of a total of 355 surveyed. The results indicated that pricing was the most important attribute in a service bundle, followed by minutes included and internet access. Text messaging was calculated to be the least important attribute. To account for the accuracy of the estimated WTP figures, both linear calculation and curve fitting were conducted for the price parameter, with no significant change in results.

The current study is the first to estimate the importance to consumers of being able to use their local mobile package while travelling abroad (unrestrained roaming, in short). An increasing number of people around the world have travelling routines, and unrestrained roaming can be achieved through regulation. Furthermore, this study is an update on the consumer studies evaluating 4G, as we include in our attribute list the top data rates currently available with the most advanced 4G technologies. This will shed light on the extent of the consumer demand for ever-faster mobile data rates.

3. Methodology

3.1 Choice experiments

The origins of the CE methodology date back to Louis L. Thurstone's 1927 paper on paired (comparison) CEs. Many authors have contributed to the literature on choice analysis, and the final version of the CE methodology draws upon Lancaster's economic theory of value (Lancaster, 1966) and random utility theory (McFadden, 1973; Hanemann, 1984). CE is now commonly used in various fields of economics and marketing to make choice-based valuations of goods, services and their attributes.

What sets CE apart from other stated preference elicitation methods is that it allows researchers to study not only the value of a commodity itself, but also the values of various attributes of this commodity. These attributes are the main factors influencing people's decisions,

and hence, the value that individuals associate with each attribute is important information. In order to extract this information, the CE practitioner designs choice sets containing different levels of the attributes, and asks people in a survey to make choices between these sets. By this method, the CE practitioner is able to analyse the marginal effect of each individual attribute on the consumers' utility.

In the context of this research, CE methodology enables us to break down the improvement in mobile services into the individual attributes that we intend to study. We can thus estimate separate marginal WTP figures for each individual attribute.

3.2 Attributes and attribute levels

The attributes for the study are identified through an extensive review of related literature and through focus groups held with representative consumers.

Previous choice studies in MC literature, as mentioned in section 2.2, have each utilized a different list of attributes. Kim (2005) selected mobile internet, video telephony and global roaming as the attributes of interest for a mobile service. Shin et al. (2011) investigated preferences for company name, discounts, service quality and availability of MNP. Kwak and Yoo (2012) identified five attributes of 4G technology, namely data rates, quality, number of broadcasting channels, VOD service and supplementary services. Klein and Jakopin (2014) investigated service bundling.

In the current research, two distinct focus groups are conducted with representative consumers to determine what they value in their mobile service, and which improvements they would be interested in. As 4G is yet to be introduced in North Cyprus, the principal consensus among the focus groups is that increased data rates and improved quality through the adoption of 4G are valuable for everyone. With 4G, mobile data transfer rates increase from around 3 Mbps to a minimum of 30 Mbps and a maximum of 300 Mbps. The higher the data rates, the better the users' experience with data-intensive mobile applications such as videophoning and cloud

computing. The quality of communication is also improved with 4G because of the shorter transition time between transmitters, which avoids freezing and disconnection while the user is speaking or surfing the net on the move. Increased data rates and improved quality are the two attributes that we take into our attributes list, and that have been previously studied (Kwak and Yoo, 2012).

We do not find strong justification to include in our study the other attributes mentioned in the literature. The concept of broadcasting channels was difficult for most participants to grasp, and its impact for the consumer is already captured by the attributes of data rates and quality. Video telephony and VOD are already offered by third-party applications, and mostly free of charge, so people are not willing to pay extra for these services. Mobile internet and global roaming are already available in today's standard subscriptions, and MNP, though currently not available in North Cyprus, is believed to be a consumer right and likely to receive too many 'protest zero' valuations. Service bundling is not the focus of this paper, since we are interested in improvements in mobile services, rather than the bundling of existing services.

The focus groups identify two new attributes that are not mentioned in the literature but that are mentioned very frequently by our representative consumers. The first one is unlimited mobile internet use. Respondents are discontent with the state-run ADSL internet service, which is the only fixed broadband service available in North Cyprus. The system lacks capacity, the infrastructure is old and troubled, and, besides, ADSL technology is limited to a maximum speed of 8 Mbps. The faster cable and fibre technologies would be too costly to introduce, so the only remaining option is wireless connection. If mobile operators were to offer unlimited internet use instead of imposing data caps, many people would be willing to replace their fixed home connection with a mobile subscription.

The second new attribute is unrestrained use of mobile services when abroad. Cyprus is a small island in the Eastern Mediterranean, and citizens of North Cyprus frequently travel to two

destinations: Turkey and South Cyprus. They travel for business, for entertainment, for shopping, or simply to take a flight to a third destination. However much they travel, they cannot use their home mobile subscription freely, so they end up paying extra roaming fees or purchasing another local mobile number. If their mobile service offered unrestrained use in Turkey and South Cyprus, which is possible through bilateral roaming regulation between governments, people could use their home minutes and data plans in these destinations.

The final list of attributes and attribute levels is presented in Table 1. Mobile internet speed (more comprehensible than 'data rates') has three levels: 3 Mbps with the current 3G service, 30 Mbps with basic 4G implementation, and 300 Mbps with the most advanced 4G technology. Mobile internet limit and quality each have two levels. The present level for quality refers to the quality experienced with 3G, and better quality refers to the 4G experience (i.e. no freezing/disconnection while speaking and surfing the net on the move). We also split the attribute for unrestrained use in Turkey and South Cyprus into two attributes, because a separate bilateral roaming regulation is required for each.

Table 1. Attributes and attribute levels

Attribute	Number of levels	Levels
Mobile internet speed	3	Present speed (3 Mbps), 10 times faster (30 Mbps), 100 times faster (300 Mbps)
Mobile internet limit	2	Limited/meter-rate, Unlimited
Quality (speaking and internet)	2	Present level, Better quality
Unrestrained use in Turkey	2	No, Yes
Unrestrained use in South Cyprus	2	No, Yes
Additional monthly subscription cost[a]	4	20 TL, 40 TL, 60 TL, 80 TL

[a]At the time of the survey (March 2015), 2.52 TL (Turkish lira) was approximately equal to 1 USD.

3.3 Experiment design and choice sets

There are various classes of design that can be used in a CE. The most general class is the full factorial design, in which all possible combinations of the attribute levels are used. In this way

the decision-makers reveal their preferences for all possible combinations and the researcher is able to fully observe their behaviour. However, as the number of attributes to be used increases, the size of a full factorial design grows exponentially. Using all possible treatment combinations in this particular study would require us to ask $(3\times2^4\times4)^2$ choice questions in total. Since this would be impractical, we opt for an orthogonal main effects design, which reduces the size of the experiment and also maintains zero correlations between the attributes (Hensher et al., 2005).

We generate our experiment design using the SPSS v20 software package. The design consists of 32 treatment combinations, or profiles, which we divide into 8 blocks so that each survey respondent receives 4 choice questions. Although many previous studies in the literature employed eight choice questions per respondent (Paulrud and Laitila, 2010; Kwak and Yoo, 2012), we believe we can eliminate effects of fatigue by limiting the survey to four questions. We also duplicate each version of the survey for the purposes of randomizing, by reversing the order of the first two choice questions and the last two choice questions in each duplicate. This helps to minimize the effects of order bias in the study. We end up with 16 versions of the survey, each with 4 choice questions.

Every choice question in the survey presents the respondent with two new mobile services (A and B) with varying levels of the attributes, and the respondent's existing mobile service (C) to choose from. The respondent has the option to transfer to a new service or to stay with the existing service. Because current technology in North Cyprus is 3G, and because the local operators do not offer plans with unlimited internet or unrestrained use abroad, the attribute levels for service C are fixed in every choice question. Table 2 displays a sample choice question from the survey.

Table 2. Version 2a Choice Set 1

	Service A	Service B	Service C (Current Service)
Mobile internet speed	10 times faster (30 Mbps)	100 times faster (300 Mbps)	Present speed (3 Mbps)
Mobile internet limit	Limited/meter-rate	Unlimited	Limited/meter-rate
Quality (speaking & internet)	Better quality	Present level	Present level
Unrestrained use in Turkey	Yes	No	No
Unrestrained use in S. Cyprus	Yes	No	No
Additional monthly cost	80 TL	60 TL	0 TL
Your Choice	[ ]	[ ]	[ ]

3.4 Survey and data

The survey was conducted in March 2015 by a professional polling firm, Prologue Consulting Ltd. A total of 320 individuals were interviewed in all five districts of North Cyprus, complying with the rule of thumb for the minimum sample size required to estimate results that are representative of the population (Orme, 2006). The sampling technique used was exogenous stratified random sampling (ESRS), in which the sampling frame is divided into five strata based on the five districts of North Cyprus. Targets for the number of interviews in each district were identified using the latest census data. Random sampling was performed within each district, reflecting the characteristics of the population with reasonable accuracy.

In-person interviewing was used as the survey administration mode, because the concepts in the study are fairly complicated and respondents may need guidance in answering choice questions. The concepts and attributes were explained thoroughly in a document preceding the section containing the choice questions. The survey also included a section that elicits information from respondents about their experience with mobile services, and a section that collects demographic data. Table 3 below presents a summary of this data.

Table 3. Summary statistics

Variable	No. obs.	Mean / %	Std dev.	Min.	25th %tile	Median	75th %tile	Max.
Mobile experience data								
Mobile device ownership	320							
Regular mobile phone	68	21%						
Smart phone	283	88%						
Tablet	76	24%						
Laptop	144	45%						
Mobile subscription	320							
I have	320	100%						
I do not have	0	0%						
Mobile subs. expenditure (TL/month)	320	107.23	91.98	20	50	80	130	800
Frequency of mobile internet use	320							
Every day	221	69%						
Several times a week	61	19%						
Several times a month	4	1%						
Very rarely	3	1%						
Never	31	10%						
Purpose of mobile internet use	288							
Search engines	172	60%						
E-mail	100	35%						
Instant messaging	190	66%						

Table 3 (Continued)

Variable	No. obs.	Mean / %	Std dev.	Min.	25th %tile	Median	75th %tile	Max.
Voice over IP	97	34%						
Videophone	72	25%						
Social networking sites	255	89%						
News sites	175	61%						
Watching videos	118	41%						
Watching movies	66	23%						
Other mobile applications	84	29%						
Cloud computing	31	11%						
Mobile hotspot	41	14%						
Time spent using mob. int. (hrs/week)	289	24.58	19.77	2	10	20	35	140
Demographic data								
County	320							
Girne	75	23%						

Güzelyurt	36	11%						
İskele	24	8%						
Lefkoşa	109	34%						
Mağusa	76	24%						
Age	320	33.75	10.68	18	26	31	40	63
Gender	320							
Female	156	49%						
Male	164	51%						
Marital status	320							
Married	171	53%						
Not married	149	47%						
Education	320							
Primary school	25	8%						
Secondary school	33	10%						
High school / Vocational school	118	37%						
University (2-year)	55	17%						
University (4-year)	81	25%						
Graduate school (Master)	5	2%						
Graduate school (Doctorate)	3	1%						
Employment	320							
Employed	226	71%						
Unemployed / out of labour force	94	29%						
Net monthly income (TL/month)	269	2,504.41	1,557.50	300	1,600	2,000	3,000	11,000

4. Empirical Model

4.1 Random utility theory

CE methodology makes use of the random utility theory. An individual, when faced with an alternative i, derives a utility from this alternative as follows:

$$U_i = V_i + \varepsilon_i$$

The component V_i is observable to the researcher, and the random component ε_i is not. The observed component V_i is where the set of attributes that are observable and measurable

reside. The simplest assumption for V_i would be that it is a linear function of the attributes, each of which is weighted by a unique weight to account for that attribute's marginal utility input. Using f as a generalized notation for functional form, but noting that the functional form can be different for each attribute, we can write V_i as:

$$V_i = \beta_{0i} + \beta_{1i} f(X_{1i}) + \beta_{2i} f(X_{2i}) + \beta_{3i} f(X_{3i}) + \cdots + \beta_{Ki} f(X_{Ki})$$

where X_{ki} represents the $k = 1$ to K attributes of alternative i, β_{ki} represents the weights of these attributes, and β_{0i} is a parameter that is not associated with any observed attribute, but represents the role of all unobserved sources of utility.

4.2 Multinomial logit model

We treat each attribute in our study to be linear so that $f(X) = X$; we assume the random component of utility ε_i to be inclusive of all sources of variance from unobserved components of β and X, and also that ε_i is IID (independently and identically distributed). We end up with the multinomial logit (MNL) model:

$$U = ASC + \beta_{fast} X_{fast} + \beta_{veryfast} X_{veryfast} + \beta_{unlimited} X_{unlimited} + \beta_{quality} X_{quality} + \beta_{turkey} X_{turkey} + \beta_{southcyprus} X_{southcyprus} + \beta_{price} X_{price} + \varepsilon$$

The alternative-specific constant (ASC) represents the utility derived from the existing service, and it captures the real and psychological costs of switching to a new service. The attribute variables X, except for the price attribute, are binary variables taking on the value 1 when the attribute is present in the service and 0 if it is not present. It should also be noted that we split the attribute for mobile internet speed into two attributes: fast speed and very fast speed. This is because we would like to detect the non-linear impact of moving from the present speed

(3 Mbps) to 10 times faster (30 Mbps), and also from 10 times faster (30 Mbps) to 100 times faster (300 Mbps).

As the form of the utility expression is identified, we turn to how an individual makes a choice in a CE. The individual faces $j = 1$ to J alternatives, where $J = 3$ in our survey. In order to make a choice, the individual will evaluate the utility she or he will derive for each alternative and pick the one with the highest utility. Putting this into notation, the probability that alternative i will be chosen is:

$$P_i = P\left(\left(U_i \geq U_j\right) \forall\, j \in j = 1, \dots, J; i \neq j\right)$$

Rearranging gives us:

$$P_i = P\left(\left(V_i + \varepsilon_i \geq V_j + \varepsilon_j\right) \forall\, j \in j = 1, \dots, J; i \neq j\right)$$

$$P_i = P\left(\left((\varepsilon_j - \varepsilon_i) \leq (V_i - V_j)\right) \forall\, j \in j = 1, \dots, J; i \neq j\right)$$

Since the left-hand side of the inequality is not observable, estimating the model requires picking up a probability distribution for the 'error term'. A popular distribution in discrete choice analysis is the extreme value type 1 (EV1) distribution, which has the following form:

$$P\left(\varepsilon_j \leq \varepsilon\right) = \exp(-\exp -\varepsilon)$$

Equipped with the IID and EV1 assumptions, we proceed to complete the model. Louviere et al. (2000, Chapter 3) took on the full derivation of the MNL model, and ended with the following:

$$P_i = \frac{\exp V_i}{\sum_{j=1}^{J} \exp V_j} \;;\quad j = 1, \dots, i, \dots, J \quad i \neq j$$

In words, this states that the probability of an individual choosing alternative i out of J alternatives is equal to the ratio of the exponential of the observed utility index for alternative i to the sum of the exponentials of the observed utility indices for all J alternatives including the ith alternative.

4.3 Estimating the model and WTP

Our model can be estimated using maximum likelihood techniques. Letting I_{nj} be a dummy variable that takes value 1 if individual n chooses the alternative j and 0 otherwise, the log-likelihood function of the model for a total number of respondents N is given by:

$$\ln L = \sum_{n=1}^{N} \sum_{j=1}^{J} I_{nj} \ln P_{nj}$$

The parameters to be estimated are the weights β of the attributes in the utility function, and these can be estimated by maximizing the log-likelihood function above (it should be noted that the weights β reside inside the term P_{nj}). Once β are estimated, we can calculate the WTP figures. Since X consists of $K = 7$ attributes and one of the attributes is the price attribute p, the marginal WTP for a change in the level of a single attribute k and the WTP for the entire service in the question resulting from changes in levels of all attributes are given by (Lancsar and Savage, 2004):

$$MWTP_k = \frac{\frac{dV}{dX_k}}{-\frac{dV}{dp}} = \frac{\beta_k}{-\beta_p}$$

$$WTP = \sum_{k=1}^{K} \frac{\beta_k}{\beta_p} (\Delta X_k)$$

5. Results

The results of the model estimation[1] are presented in Table 4. In order to determine the goodness of fit of the estimated model, we compare it to the constants-only model using the likelihood-ratio (LL-ratio) test. LL for our model was computed as −1,154.13, and LL for the constants-only model as −1,340.89. The formula for the test is:

$$-2(LL\ base\ model - LL\ estimated\ model) \sim chi\ square$$

The degrees of freedom (d.f.) for the test is the difference in the number of parameters estimated by the two models. For our model,

$$-2LL = -2\big(-1340.89 - (-1154.13)\big) = 373.52$$

At the 95% significance level, the critical value of chi square with d.f. 7 (= 8 – 1) is 14.07. Since the value of −2LL function, 373.52, is greater than this chi-critical, we reject the null hypothesis that the estimated model is not better than the base model.

Table 4. Results of MNL model estimation

Variables	β-coefficient	Standard Error	95% Confidence Interval	
ASC	−.59350***	.16673	−.92029	−.26671
FAST	.63411***	.11140	.41578	.85245
VERYFAST	.71585***	.12728	.46638	.96531
UNLIMITED	.25375***	.08938	.07857	.42893
QUALITY	−.15118*	.08865	−.32494	.02257
TURKEY	.92894***	.09394	.74482	1.11307
SOUTHCYPRUS	.61745***	.09041	.44025	.79465
PRICE	−.03141***	.00234	−.03599	−.02683

Note: ***, **, * indicate statistical significance at the 1%, 5%, 10% levels, respectively.

[1] The MNL model is estimated using NLOGIT v5.0 software package.

All the estimated coefficients for the attributes in the utility function are significant at the 1% level, except the coefficient for the quality attribute. The coefficient of quality is statistically insignificant at the 1% and 5% levels, and its 95% confidence interval contains zero. We conclude that the study finds no evidence that an improved quality of mobile services will enhance consumers' utility.

The signs of the estimated coefficients are consistent with our expectations (again, except for the quality attribute, which we already accepted to be statistically insignificant). Attributes for fast speed, very fast speed, unlimited internet, unrestrained use in Turkey and unrestrained use in South Cyprus all have a positive impact on consumers' utility, whereas price has a negative impact. The estimated coefficient for unrestrained use in Turkey is the greatest, which implies that this is the attribute that improves consumers' utility the most. Coefficients for very fast speed, fast speed, unrestrained use in South Cyprus, and unlimited internet use follow, respectively.

We can calculate the MWTP for each attribute from the estimated coefficients, using the formula given in section 4.3. Table 5 shows the MWTP figures and their 95% confidence intervals. The confidence intervals are computed using EC Fieller's method (Motulsky, 1995).

Table 5. MWTP for the attributes

Attributes	MWTP (TL/month)	95% Confidence Interval (TL/month)	
Fast mobile internet speed (30 Mbps)	20.19	12.98	28.28
Very fast mobile internet speed (300 Mbps)	22.79	14.56	32.01
Unlimited mobile internet use	8.08	2.49	14.02
Improved quality (speaking and internet)	−4.81	−10.56	0.72
Unrestrained use in Turkey	29.57	22.83	37.61
Unrestrained use in South Cyprus	19.66	13.67	26.50

The attribute with the greatest MWTP is unrestrained use in Turkey. Consumers, on average, are willing to pay an extra 29.57 TL (11.73 USD) per month for their MC service if they

receive unrestrained use in Turkey. The amount they are willing to pay for very fast internet speed at 300 Mbps is 22.79 TL (9.04 USD) per month, whereas it is 20.19 TL (8.01 USD) per month for a more modest internet speed of 30 Mbps. The MWTP figures for unrestrained use in South Cyprus and for unlimited internet use are 19.66 TL (7.80 USD) and 8.08 TL (3.21 USD) per month, respectively. The MWTP for improved quality is a negative value; however, its 95% confidence interval contains zero, and we can assert that estimated MWTP for improved quality is not different from zero at the 5% level of significance.

These results indicate strong consumer preference for mobile services to be available in Turkey and in South Cyprus with no restrictions. The survey respondents are paying an average of 107.23 TL/month (see Table 3) for their current service, and are willing to accept a 28% increase in their monthly mobile bill for unrestrained roaming in Turkey and an 18% increase for the same in South Cyprus. The reason that roaming in Turkey is valued higher than that in South Cyprus could be that citizens of North Cyprus travel to South Cyprus by car mostly for day trips, whereas they take a flight to visit Turkey and stay longer. It could be argued that consumers can handle missing out on mobile services for short periods, but not for longer trips.

The results of the study also suggest that there is substantial demand for the upgrade of mobile services in North Cyprus to the 4G grade, with unlimited use if possible. Consumers are willing to pay 19% to 21% more than they currently pay in order to have faster 4G-rate connection speeds, and 8% more in order to receive unlimited mobile internet use. These results are in line with the survey statistics in Table 3, which show that consumers are already using data-intensive mobile applications such as social networking (89%), instant messaging (66%) and watching videos (41%). Faster data rates will enhance consumers' mobile experience.

6. Discussion and Conclusions

The aim of this study is to explore the current issues in the North Cyprus mobile services market, and to find out the most valuable service improvements for the people. We select the

attributes of interest through a careful process of preliminary research. MNP is one important improvement that people demand, but without any additional cost, as they believe MNP is a consumer right. Therefore, we exclude MNP from our final list of attributes.

The current mobile technology available in North Cyprus is 3G. It is rumoured that the government will be auctioning 4G licences in the near future. Although 4G is deployed in many countries, North Cyprus is not the only one on the 'waiting list'. There are many regions with no 4G coverage in the 4G-active countries; in addition, there are the remaining non-active countries, which have yet to benefit from improved data rates provided by 4G. In fact, most areas that do have 4G coverage have to settle for only a fraction of the top speeds offered by the most advanced technology. According to a report by OpenSignal in March 2015 (Westwood, 2015), the USA ranks 26th in the world for 4G data rates, with an average rate of 7 Mbps, much less than the 300 Mbps achieved by 4G LTE-A CA technology. There is room for growth for the 4G market all over the world, and there is a need for more empirical research on the sector in order to determine whether new investments on technology are viable. This study is the first attempt in the MC literature to evaluate consumer preferences for several levels of mobile data rates, including the top rate possible as of today.

Another potential value of mobile telecommunications is that it could replace fixed broadband connection to homes, especially in remote areas where there is no existing fixed infrastructure. It would be very costly to lay new fibre or cable infrastructure to sparsely populated regions, and wireless connection via mobile operators could be a solution. The EU's Digital Agenda requires that the entire EU be covered by broadband above 30 Mbps by 2020 (EC, 2015). In areas such as North Cyprus that are currently lagging behind, 4G could prove to be the most economical way to achieve this aim. However, 4G needs to be offered to the consumer with no data caps if it is to compete with fixed broadband technologies. This paper also addresses the question of whether removing the data caps has any value for consumers.

Finally, it is a common problem for people who are travelling to have to pay excessive roaming fees for their mobile services while abroad. This problem could be solved through bilateral action between governments aimed at regulating roaming fees for visitors in their countries. The EU, for one, has put great effort into regulating roaming between EU member states. Infante and Vallejo (2012) reported that "intra-EU voice and SMS roaming prices have suffered a steep decline from 2007 to 2010, following the glidepath set by regulation". Unfortunately, roaming regulation is very low down on government agendas elsewhere, and this study is the first to quantify how valuable such a policy could be for the population in a developing country.

The most obvious policy implication of the study is that the government of North Cyprus can produce great value for the population simply by making bilateral roaming deals with the governments of neighbouring countries. We find that unrestrained use in Turkey is the most valued item in our attributes list (29.57 TL per month). In addition, using the formula in section 4.3 for the addition of MWTPs, we find that the elimination of roaming fees in both Turkey and South Cyprus is worth a total of 49.23 TL per month for consumers. This is more than twice the value of introducing 4G, which we find to be worth around 20 TL per month. In fact, it is about 2% of the average monthly income of the survey respondents (reported as 2,504.41 TL per month in Table 3). This is a substantial ratio that policy-makers cannot overlook, and hence, we conclude that they should move roaming regulation to the top of their agendas.

Despite scoring lower than unrestrained roaming, 4G is also very valuable for consumers in North Cyprus, according to the results of our study. This is a message to the government of North Cyprus, and to the administrations of all regions not covered by 4G, that they need to accelerate the pace of introduction of 4G. Two other very useful findings concerning 4G relate to the quality and the data rates to be provided with 4G. First, we find that consumers are happy with the quality they experience with 3G, and are not willing to pay anything extra for improved

quality. We conclude that 4G investments in North Cyprus may opt not to focus on quality improvements. Second, we find that consumers' MWTPs for a 30 Mbps 4G experience (20.19 TL per month) and for a 300 Mbps 4G experience (22.79 TL per month) do not differ greatly. In fact, we calculate the 80% confidence limits for the difference of these MWTPs to be −4.30 and 9.51, using EC Fieller's method (Motulsky, 1995). This interval contains the zero point, so we cannot reject at the 20% level the null hypothesis that people are indifferent between 30 Mbps 4G and 300 Mbps 4G. Restating this from another perspective, we can reject the null hypothesis that 300 Mbps 4G is worth at least 10 TL more than 30 Mbps 4G, with 90% confidence. Either way, the conclusion is that mobile operators in North Cyprus (and, possibly, in most countries in the world) need not build the most advanced (and costly) 4G technology that provides the top data rates that are technically possible, at least not for the time being.

In summary, the findings of the stated preference study presented are highly significant. We conclude by noting that the realized values could even exceed the figures calculated. In our CE, the interviewees made their choices for the 4G improvements without actually experiencing the benefits. After 4G is implemented in North Cyprus and the consumers are more aware of the capabilities of the technology, they could place a higher value on 4G, if asked about the compensation they would require to give up 4G. This is in fact the difference between WTP and WTA (willingness to accept) evaluations, and theorists have long debated which of these represents the true valuation of a commodity or a service (Hanemann, 1991). Furthermore, our analysis of the value of bilateral roaming regulation in this study is one-sided, estimating the value for the consumers of mobile services in North Cyprus only. North Cyprus is a small island economy that thrives on tourism. When the government of North Cyprus makes a deal with its counterpart in Turkey, for instance, to take action on excessive roaming fees in both territories, this will benefit not only North Cypriot citizens travelling to Turkey, but also Turkish tourists visiting North Cyprus. This, in turn, will enhance the tourist package that North Cyprus is offering to the Turkish market and attract more tourists to North Cyprus from Turkey. Thus, the

roaming regulation will create considerable value for the tourism sector in North Cyprus, in addition to the value created for the consumers of mobile services.

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