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Estimation of Switching Costs and Network Effects in Mobile Telecommunications in Poland.

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ABSTRACT

In this paper we utilize discrete choice experiment method to identify and measure switching costs and network effects in mobile telephony in Poland. Based on hypothetical choices consumers make we construct a conditional random parameters multinomial logit model to analyze their preferences. In our choice design we explicitly account for status quo inertia, number portability, operator brand, network distribution of most frequently called parties and price of on-net and off-net calls. Stated preference approach allows us to calculate marginal rates of substitution and hence implicit prices of the non-price attributes used to describe choices and switching behavior.

Results of our study indicate that although choices of mobile operators are largely driven by price of calls, switching costs and network effects have and strong impact on utility of subscribers. In particular users assign positive value to their mobile phone number and the size of family and friends group in the same network. The monetary value of phone number is significantly higher among individual entrepreneurs than residential subscribers. In our model switching behavior is not discouraged by brand loyalty which turned out to be insignificant. Instead subscribers follow status quo inertia which reflects uncertainty associated with new operator. Therefore we conclude that despite introduction of mobile number portability, switching costs continue to be an important issue in telecommunications markets.

On recommendations level, we argue that regulatory and competition policies should continue to reduce uncertainty associated with changing operator by ensuring service and platform compatibility and reducing tariff complexity. In light of our results we recommend tariffs to be non-discriminatory so that operators are unable to utilize network effects in a way which discourages switching behavior.

KEYWORDS

Switching costs, network effects, mobile telecommunications, mobile number portability, brand valuation, stated preference methods, non-market valuation methods, choice experiment, multinomial conditional logit model, random parameters model.

JEL CLASSIFICATION

L1; L86; O3

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1 INTRODUCTION

Switching costs attract a lot of attention in empirical research and regulatory policy especially in telecommunications and markets for electronic services such as social networking or internet banking. In telecommunications there exist several specific types switching costs such as SIM locking policy, number portability, platform compatibility or brand loyalty which constitute different generic categories such as contractual costs compatibility costs or uncertainty costs. Number portability is probably the most studied issue in empirical research on switching costs in telecommunications with various datasets, modeling approaches, different sets of control variables and different objectives focusing either on identification, measurement or implications for market competition.

This paper focuses on measuring the value of number portability while controlling for network effects and status quo inertia, which captures other types of switching costs such as uncertainty and compatibility costs. Although switching costs and network effects create similar lock-in mechanisms there are very few papers which integrate both phenomena into one model of subscriber's behavior. While switching costs are related to discontinuity of service and are imposed directly on customers, network effects are external benefits generated by other subscribers in the same network which user forgoes while switching to different network.

The expected positive result on market competition from introduction of number portability depends not only on porting conditions and price for the service. ([Shi, Chiang et al. 2006](#)) argue that from theoretical perspective large firms can mitigate the effects of lower switching costs by increasing exposure of their customers to network effects. Mitigation strategy can be easily exercised in telecommunications markets by introducing discriminatory pricing scheme. By measuring relative importance of both effects we can gain more insight into feasibility and costs of this strategy.

The rest of the paper is organized as follows. In the next section we briefly review relevant literature. In section 3 we describe the structure of mobile phone market in Poland and characterize our sample. In section 4 we provide model specification and estimation results. The last section provides discussion and conclusions.

2 LITERATURE REVIEW

Switching costs and network effects are the two hot topics in industrial organization for over three decades. Both phenomena are still intensively studied in various empirical applications and continue to receive a lot of attention from regulators concerned with competition policy. Switching costs can be defined as real or perceived costs that are incurred when changing supplier but which are not incurred by remaining with the current service provider ([Padilla, Williams et al. 2003](#)). They create economies of scale in repeat purchasing and consequently service providers increase their market power over installed customer base. Direct network effect is a positive externality which arises due to horizontal compatibility between network

nodes. Compatibility increases the value of network subscription with the number of existing subscribers. With strong network effects and incompatibility largest firm can easily mitigate competition and push market to corner equilibrium ([Economides 1996](#)).

Early theoretical contributions such as ([Katz and Shapiro 1985](#)), ([Farrell and Saloner 1985](#)) and ([Klemperer 1987](#)) treated both phenomena separately and most empirical work in various applications followed the same path. ([Farrell and Klemperer 2007](#)) provide a comprehensive review of both switching costs and network effects and stress that they are different in nature, but have similar consequences for market competition and consumer lock-in. ([Klemperer 1995](#)) argues that general reluctance to switch can be driven by various costly factors such as uncertainty or incompatibility costs. The main conclusion emerging from literature indicates that switching costs usually make market less competitive and thus should be subject of regulatory concern, especially when their nature is partly endogenous.

In the context of telecommunications switching costs have been analyzed in numerous papers dealing mainly with number portability. ([Viard 2007](#)) shows that introduction of 0-800 number portability in US reduced wholesale prices by 4.4%. ([Lyons 2010](#)) based on panel data from several countries estimates the price reduction resulting from mobile number portability at 7% and argues that MNP is effective only if porting time is less than 5 days. Two papers use similar modeling approach to ours and estimate monetary value of number portability for Korea ([Lee, Kim et al. 2006](#)) and Japan ([Nakamura 2008](#)) at about 10 euro, but without controlling for network effects in their choice designs. ([Nakamura 2010](#)) uses discrete choice experiment to model portability of content and handsets across service platforms of different operators. ([Grzybowski and Pereira 2011](#)) use individual panel data to analyze subscription choices for Portugal. They show that switching costs largely affect choice probabilities and also that price mediated network effects mitigate the impact of switching costs on market structure.

Much effort has also been devoted to study network effects in telecommunications. Most notably ([Liikanen, Stoneman et al. 2004](#)) found positive direct network effects between analogue and digital generations of mobile phones as well as within their 2G generation. ([Doganoglu and Grzybowski 2004](#)) as well as ([Grajek 2007](#)) found evidence of a very low economic compatibility between different GSM networks, which indicates the presence of strong network effects on the operator level in mobile telephony. They also find that the degree of incompatibility increases with the price discounts for on-net calls. ([Czajkowski and Sobolewski 2011](#)) showed that scale and scope of this impact may depend on many market- and user-specific factors, such as technology, on-net price discounts, the structure of subscriber usage profile, network distribution of their most frequently called parties and many others.

Our work contributes to the existing empirical literature on switching costs by applying discrete choice modeling to estimate monetary value of: (i) two types of switching costs including number portability and (ii) network effects. We provide insights into the nature of network effects and check where they are located and what is their importance in comparison to number portability and status quo inertia. To our knowledge this is the first modeling attempt to identify and measure different mobility barriers in mobile telephony.

3 EMPIRICAL STUDY

3.1 MARKET OVERVIEW

Polish mobile telecommunications market is now at full maturity, with SIM-card penetration at around 140%. Out of four infrastructural operators in Poland, three companies are early GSM incumbents and the fourth entered the market much years later at stage of UMTS deployment. In the end of 2012 the three incumbent companies still had dominant position controlling 82% of the market with almost equal market shares, however their dominance consequently weakens year-by-year in favor of the entrant who achieved 16% market share ([UKE 2013](#)).⁴

Since 2002 incumbent operators have been offering 3G services with similar network coverage.⁵ In 2005 Office of Communications (UKE) granted the fourth UMTS license to a new entrant – Play Mobile (P4). Play started its 2G operations in 2007 under national roaming agreement with Plus and 3G services in its own UMTS network. By that time it was already too late for large scale entry due to high market penetration of incumbents, which further took advantage of large switching costs and strong network effects to protect their installed subscriber bases. As a result by 2010 Play managed to build only 5% share in the market despite heavily subsidizing its customer base, which put this operator into losses. But since the last two years the competitive situation has changed substantially due to facilitation of number portability procedure which together with achievement of critical mass put Play on the fast expansion path. Now Play has 16% market share and experiences upward trend in adoptions. Late entrant outperforms all three competitors with respect to net inflows of new subscriptions and switching customers by offering simpler and more attractive tariff plans.⁶

From the beginning NRA supported the network expansion of the late entrant with asymmetric MTR rates. Originally the asymmetry in favor of P4 was more than 200%, however both MTR levels and their asymmetry have been decreasing gradually in later years. Since January 2013 all interconnection rates have been equalized and further reduced to a current level of 0.04 pln per minute.⁷ There are numerous virtual mobile network operators (MVNOs) in the Polish market, however their importance is negligible (1,3% share in SIM cards). This brief market overview indicates on the importance of switching costs and network effects on the entry and competition between firms in Poland. Our main objective in

⁴ Market data referred in this paragraph is mostly taken from latest annual telecommunications market review published by Office of Communications (UKE), polish national regulatory authority.

⁵ These are: PTK Centertel (Orange), PTC (rebranded from Era to T-Mobile) and Polkomtel (Plus). PTK Centertel is a subsidiary of Polish Telecom Group – a former monopolist recently rebranded to Orange Poland. It was the first mobile operator in Poland. In 1991 PTK launched 1G telephony under NMT-450i and GSM telephony in 1998. PTC is a full subsidiary of T-Mobile. Polkomtel was established jointly by Vodafone and a number of large Polish state-owned companies and recently sold to investment fund controlled by polish businessman. Both operators (Plus and T-Mobile) started to offer GSM services in 1996.

⁶ For example this operator, as a first in the market, introduced plan with unlimited M2F and M2M calls for a fixed fee, forcing others network operators to respond accordingly.

⁷ Which is equivalent to 1 euro cent (1 PLN \approx 0.25 EUR \approx 0.3 USD).

this study is to see whether the existence of both phenomena is reflected on individual level in subscribers preferences.

3.2 DEVELOPMENT OF THE QUESTIONNAIRE

We aim to model the factors that influence consumers' choices of mobile phone services' providers, based on stated preference study. Such data is usually collected in the form of a survey which is distributed among a sample of target population. A choice experiment survey typically collects socio-demographic data, introduces the choice tasks that are about to follow, and presents each respondent with hypothetical situations, each time asking to indicate the most preferred alternative. In addition, a questionnaire contains mechanisms and information that are included in order to mitigate biases that might be present in hypothetical choice situations (for a comprehensive review of potential biases and ways to mitigate them see e.g. [Carson, Flores et al. 2001](#), [Bateman, Carson et al. 2004](#)).

We applied focus group interviews to reduce the number of possible choice attributes to a manageable number of five which consumers paid the most attention to, when choosing their mobile phone's operator. The first of the attributes used in the study was a brand name of the mobile operator's network. In our preliminary interviews respondents seemed to associate various qualities with different operators (brands). For this reason we have included the four brands of infrastructural MNOs currently operating on the Polish market: Orange, T-Mobile, Plus and Play. Virtual operators were excluded from the research, due to their negligible market share.

The next two attributes reflected the price of a call. We have decided to include two price attributes in our study: on-net price per minute and off-net price per minute. Operators only recently started to offer flat rate plans.⁸ However majority of subscribers are still subject to price-discrimination based on call destination. Therefore, we have included possible levels of these attributes, which were used to describe the alternatives used in choice sets presented to our respondents, reflected current prices of calls in the market and also levels perceived by participants of focus groups. These were 0.10, 0.30, and 0.50 PLN per minute for on-net calls and 0.10, 0.30, and 0.70 PLN per minute for off-net calls respectively.

The aim of our study was to measure the value of switching costs and network effects and their influence on consumers' choices. In particular in preliminary qualitative study it turned out that an essential attributes that have an impact on the choice of a new mobile operator is possibility to port one's current number. Subscribers also care about the size frequently called group such as family and friends in the new network. Calls to those groups of people generate the major part of network traffic, so their presence on the same network is important for the total cost of calls if operator price discriminates. Similar conclusions regarding the main locus

⁸ Operators started to offer flat rate plans after substantial decrease in mobile termination rates and introduction of full MTR symmetry.

of network effect can also be found in earlier literature ([Birke and Swann 2005](#)), ([Czajkowski and Sobolewski 2012](#)).

Consequently, in the questionnaire we have distinguished two exclusive groups of other people whose presence in the network can be more or less important for selecting a mobile operator. We have distinguished those groups depending on respondent's individual emotional relation with them. These two social circles are:

- ‘Family and Friends’ – people considered as closest, such as parents, siblings, partners and all persons with whom respondent maintains regular contact, such as friends, acquaintances, and relatives;
- ‘Others’ – all the other people who a respondent contacts irregularly, such as shops, offices, distant friends, or does not contact at all, but are still connected to the same network. This attribute was basically equivalent to each operator's customer base.

As a result, each of the alternatives in a choice situation has been described by the two additional attributes, associated with the percentage of people who they consider their ‘family and friend’ and ‘others’ who would also be subscribers of the same operator. Both these attributes could take the levels of 25%, 50%, and 75%.

The last attribute called ‘number’ related to the number portability. This is a switching cost attribute that takes either value ‘new number’ – meaning no possibility to port current number to a chosen service provider or the value ‘existing number’ – indicating costless and immediate number portability between service providers.

The full list of attributes and their possible levels used in the study is summarized in Table 1.

Table 1. The list of attributes used to describe choice alternatives, and their levels

Brand of the operator	<ul style="list-style-type: none"> • Orange • T-Mobile • Plus • Play
On-net price (PLN per minute)	<ul style="list-style-type: none"> • 0.10 • 0.30 • 0.50
Off-net price (PLN per minute)	<ul style="list-style-type: none"> • 0.30 • 0.50 • 0.70
% of ‘family’ using the same operator	<ul style="list-style-type: none"> • 25% • 50% • 75%
% of ‘friends’ using the same operator	<ul style="list-style-type: none"> • 25% • 50% • 75%
Phone number	<ul style="list-style-type: none"> • New number • Existing number

The survey was structured as follows. In the beginning the purpose of the survey was explained and we assured anonymity of each respondent's individual answers. Then questions

referring to the current use of a mobile phone followed – type of contract, current mobile operator, and calling profile such as volume of generated traffic and the average monthly bill. In the next part of the questionnaire we introduced the choice tasks to follow – we described the attributes and their possible levels. We clearly defined the groups of ‘family and friends’ (f&f) and ‘others’ in the survey. The number portability functionality has been clearly described as well as consequences of having to use new number when changing mobile service provider. Finally, the choice tasks followed. For each choice situation a respondent was asked to choose an alternative he prefers the most, in terms of the attribute levels that described it.

After each indicated choice respondent was asked whether he or she prefers the chosen alternative to actual his or her actual tariff plan with respect to given attributes. This question was repeated after each choice to verify whether there exists a status quo inertia related to general reluctance towards switching to a new plan.

In the last part of the questionnaire we collected socio-demographic data such as age, gender, household size and income of the respondents.

In our study, each respondent was faced with 12 choice tasks, each consisting of 4 alternatives. Each alternative was described with the 5 attributes, specified above. An example of a choice card shown to respondents is given in Figure 1. The choice sets utilized in our study were prepared using Bayesian efficient design (see Section 2.2 for details).

Figure 1. Example of a choice card (translation)

Which of the following mobile phone operators' offers would you consider the best for yourself?

Operator	ORANGE	T-MOBILE	PLUS	PLAY
Number	existing	new	existing	new
On-net price per minute (PLN)	0,10	0,10	0,50	0,50
Off-net price per minute (PLN)	0,70	0,30	0,70	0,30
'Family and Friends' in the same network	75%	25%	25%	75%
'Friends' in the same network	75%	50%	25%	50%
Your choice	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Now compare the choice with your current plan. Tick the box, if you consider your current plan to better with respect to listed attributes from the indicated choice .

The final survey was conducted on a country-wide random sample of 903 subscribers to polish mobile operators. This resulted in 11964 choice observations. Our sample is representative, so that our empirical estimations of value of number portability and of network effects and their characteristics which are presented in section 3.6, have broader validity and can be generalized to the population of individual mobile users in Poland.

3.3 CHARACTERISTICS OF THE SAMPLE

We now turn to reporting the basic characteristics of our sample data. Some sample characteristics will be useful in interpreting the results presented in Section 4.

Apart from the section on choice set questions the questionnaire contained a series of questions regarding the usage profile of voice telecommunications. In this part of questionnaire we asked about characteristics of currently used mobile plans for which the respondent paid from own pocket. On surveying stage we have included respondents with private individual plans and business plans of owners of small or medium enterprises (entrepreneurs) but excluded individuals with company plans paid by an employer. Below we present characterization of our sample.

The largest number of respondents had a mobile phone operated by Orange (28%), followed by Play (26%), Plus (24%) and T-Mobile (21%). The remaining 1% of users subscribed to small virtual mobile operators. These results apply only to individual private users and differ from the market shares in overall Polish market shares, presented in the previous subsection. Play has much stronger position in individual users segment than in business segment which is primarily targeted by Plus and T-Mobile. This difference in reported market shares for Play can be explained with two arguments. Firstly, in mobile telecommunications both switching costs and network effects cause historical adoptions to influence future market performance. Secondly, adoption dynamics throughout product life cycle evolves from high willingness-to-pay subscribers in the beginning to low value subscribers in the maturity phase. Due to both effects, a late entrant cannot gain enough high demand, business subscribers, as they have been already captured by the three incumbent operators. More generally this is an evidence that demand for telecommunications services is differentiated, and operators introduce strategies which target different segments of the market.

According to the survey results declared prices of on-net and off-net connections averaged 0.25 and 0.34 PLN respectively. The price differentiation between the operators was relatively small. Play was declared by its users to be the cheapest operator, with prices per minute of 0.19 and 0.26 PLN for on-net and off-net calls respectively. Prices charged by the other operators were reported to be on average 0.28 and 0.40 PLN (Plus), 0.26 and 0.35 PLN (Orange) and 0.30 and 0.37 PLN (T-Mobile). Those results indicate that Play still uses a pricing strategy of a 'late entrant' aimed at expanding its customer base by attracting subscribers from mature competitors. This strategy compensates for a negative network effect by offering to newcomers unlimited on-net calls and lowering prices of off-net calls to the level of incumbents on-net rates.

We now turn to the various characteristics of usage profile of voice telecommunications in our sample and primarily findings on the importance of particular choice drivers:

- Almost 58% of respondents are subscribers to the postpaid system. An average daily usage of mobile service measured by the length of outgoing calls is 38 minutes. Users of a pre-paid service have much lower usage than post-paid subscribers (26 vis-à-vis 41 minutes). The dominant paying scheme is still based on tariffs with discriminatory rates, however 20% of respondents reported having a lump-sum plan with unlimited number of calls to all networks and another 22% have tariffs with non-discriminatory rates.
- The average monthly bill for all telecommunications services (voice, data, SMS, MMS) is 58 PLN. Play has considerably cheaper offer than Orange (60 PLN) and T-Mobile (63 PLN) with an average monthly bill of 54 PLN. This is yet another indication that Play continues to invest in market share which is a typical behavior of smaller firm on markets with switching costs and network effects ([Farrell and Klemperer 2007](#)).
- Switching behavior has been quite intense among our respondents. Half of respondents in the sample (53%) at least once changed mobile operator, one third (36%) did it at least twice. Those who switched usually port their numbers to a new operator.
- The usage profile of our sample group indicated that the vast majority of calls are established within a relatively small number of people constituting the 'family and friends' group. Median share of such connections in total time of outgoing calls is above 70%. On average, the 'family and friends' group (called from now on 'F&F') consist of 10 persons. Interestingly neither intensity of calls nor the size of 'F&F' differ across mobile operators which indicates that inside individual subscribers segment all companies have similar types of installed bases.
- We observe a tendency of "F&F" group to concentrate within the same operator, which is an indication of network effect. Half of the respondents reported that at least 50% of their 'F&F' use mobile services of the same operator as they do. With the exception of T-Mobile, other incumbent operators have more subscribers with larger shares of 'F&F' in their networks (55% each), then Play (49%). Orange and Plus have been effective in utilizing network effect strategy based on-net discounts. On the other hand T-Mobile has only 32% of subscribers with at least 50% of family and friends in its network so its installed base is more vulnerable to switching.
- In the questionnaire we have ask respondents to evaluate the importance of each choice attribute. The top three factors declared by our respondents as important or very important in selecting an operator were number portability (93%), prices for off-net and on-net connections (90 and 93%). Three remaining non-price factors: brand of operator, percentage of 'F&F' and 'others' in the same network, were reported important or very important by much fewer respondents (respectively 60%, 67% and 35%). Among those who declared the size of 'F&F' as an important driver of choice, the vast majority are those respondents who neither have flat fee (80%) nor flat rate (64%) plans. In other words the large part of subscribers for whom the size of 'F&F' in the same network matters are those who benefit from discrimination of rates. This is a direct evidence that network effects in mobile telecommunications have mainly but not exclusively pecuniary

nature. Interestingly, as much as 20% of respondents with lump sum plan and 36% respondents having plans with non-discriminatory rates also appreciate presence of ‘F&F’ in the same network. Those results suggest that at least for some part of subscribers network effect might have non-pecuniary nature.

- Our last preliminary finding is that the overall size of the operator’s network was considered irrelevant for choice. This indicates that the magnitude of network effect depends mainly on the size of the group with which a respondent maintains closer and regular interactions.
- In our sample there was 62 active entrepreneurs who run regular business. It is well known from literature that this group of subscribers has different demand characteristics and different valuation of number portability compared to the individual subscribers ([OVUM 1997](#)). This is confirmed by our sample data. Entrepreneurs use mobile services more intensively and pay higher bills, but are less sensitive to the level of prices for calls. It turned out that entrepreneurs are even more sensitive to number portability – 98% find this factor important or very important in changing service provider. On the other hand they are less sensitive to network effects because they more often make calls to ‘others’ and less care about the size of ‘F&F’ in the same network. Generally those findings provides additional support to our hypothesis on valuation of number portability which we test in our utility model.

To conclude this section, when deciding on mobile service provider, subscribers are first of all sensitive to direct price factors and number portability. To a lesser extent their choice is driven by network effects, especially due to decreasing discrimination of rates in the market and introduction of lump sum plans. We have found some partial evidence for non-pecuniary nature of network effects, however this might be an spurious finding due to a lack of long experience with non-discriminatory rates in Polish market. What we have also found out is that the strength of network effects depends on social distance. It is located mainly in family and friends group and not the absolute size of network. We verify all of the above findings quantitatively in the next section.

4 RESULTS

4.1 ECONOMETRIC MODEL

The discrete choice experiment data is obtained from properly designed surveys which include multidimensional choice situations. Every choice situation consists of a few alternatives which are described in terms of a collection of characteristics (attributes). Because these choice situations are hypothetical, a researcher can use the attributes and their levels which are relevant to the research question at hand – in some cases even the ones which are not available in the real markets. By collecting the data on the alternatives which respondents considered the best (the most preferred), it is possible to formally model their utility functions, i.e. quantify the extent to which each attribute influences choices, and find out how they are willing to trade one attribute for another. In case one of the attributes is monetary (e.g. associated with the cost of the alternative) these trade-offs reveal respondents’

willingness to pay, i.e. the rate at which they are willing to exchange their money for some changes in the attribute levels.

Formally, preference modelling is based on the random utility model ([McFadden 1974](#)). The utility function of consumer i from the choice of alternative j can be expressed as:

$$U_{ij} = \beta' \mathbf{x}_{ij} + \varepsilon_{ij}, \quad (1)$$

where β is the vector of parameters, \mathbf{x} is the vector of the levels of attributes specific for the consumer and the alternative, and ε is the random component, stemming from the inability to observe all the important characteristics of respondents or using by respondents different decision-making mechanisms ([Manski 1977](#)). By assuming that the random component is extreme value type I distributed, the multinomial logit (MNL) model is obtained which conveniently lends itself to maximum likelihood estimation of the utility function parameters ([Greene 2011](#)).

Additionally, the state-of-the-art DCE models allow to take the respondents' preference heterogeneity into account. In the random parameters logit (RPL) model, the parameters of the utility function are random variables following a priori specified distributions – $\beta_i = f(\mathbf{b}, \Sigma)$, where \mathbf{b} is the vector of the mean values of parameters in a population, and Σ – their variance-covariance matrix. Although each consumer has specified and stable parameters of the utility function, the parameters may have a specific distribution in the consumers' population reflecting their preference (taste) heterogeneity. The RPL model typically yields much better fit to the data and, at the cost of a more complicated estimation procedure, allows to avoid some of the rigid assumptions of the MNL model ([Train 2009](#)).

The final dataset included 12,060 choices made by 1,005 respondents. We analyzed the data using the RPL model assuming that all the preference parameters were random, following normal distributions. In what follows, we've assumed the following general form of the utility function of the respondents:

$$\begin{aligned} U_i = & \beta_{SQ} SQ + \beta_{ORA} ORA + \beta_{TMB} TMB + \beta_{PLU} PLU + \beta_{PLA} PLA \\ & + \beta_{NUM_R} NUM_KEEP_R + \beta_{NUM_B} NUM_KEEP_BIZ + \beta_{P_ON} P_ON \\ & + \beta_{P_OFF} P_OFF + \beta_{FF} FF + \beta_{OTH} OTH + \varepsilon_i \end{aligned}$$

Where:

- SQ – alternative specific constant associated with choosing the current mobile plan,
- ORA, TMB, PLU, PLA – operator-specific constants for Orange, T-Mobile, Plus, Play, respectively,
- NUM_KEEP_R – the plan with the current mobile phone number (regular users),
- NUM_KEEP_B – the plan with the current mobile phone number (business users),
- P_ON – on-net price per minute,
- P_OFF – off-net price per minute,
- FF – share of friends and family using the same operator,
- OTH – share of other people using the same operator.

- β are parameters associated with respective variables.

The estimation results – means and standard deviations of the normally distributed preference parameters – which best fit our sample are reported in Table 2. The parameters presented in Table 1 describe the relative importance (utility) associated with the attribute levels which were used in the DCE. Their absolute values do not have an interpretation, but their sign, relative values and statistical significance can be used, however, to illustrate what characteristics the respondents' paid the most attention to.

The results presented in Table 2 can be interpreted in the following way. Respondents are, *ceteris paribus*, reluctant to change their current mobile phone operator – this is indicated by a relatively large estimate of the SQ parameter, despite controlling for all the other differences between mobile phone operators. The possibility to keep ones number has a similar effect on choices, although we note that the importance of keeping the number for business users (NUM_KEEP_B) is almost 50% higher than for regular users (NUM_KEEP_R). In essence, these results show, that total inconvenience associated with changing the mobile phone operator is only partly (close to 50%) related to changing ones number. As a result, even if consumers are allowed to keep their numbers for free, one might still expect substantial switching costs exist, related to uncertainty about quality of service or platform compatibility ([Lee, Kim et al. 2006](#))

We found that on average no mobile phone operator is perceived significantly better than others, as illustrated by not statistically different values of operator-specific constants. We note, however, that there is high degree of unobserved preference heterogeneity – a likely sign that individuals might indeed consider some operators better than others. This effect can possibly be related to brand loyalty ([Czajkowski and Sobolewski 2012](#)).

Not surprisingly, on-net and off-net price were significant explanatory variables which negatively influenced the probability of choosing an alternative with on-net price having a larger effect. In addition, the share of family and friends (i.e. people a respondent is likely calling most often) using the same operator was highly significant and positive. This provides yet another evidence of mobile telecommunications being an industry with very significant network effects.

Finally, the results show that there is substantial unobserved preference heterogeneity with respect to most choice characteristics – this is indicated by large estimates of the standard deviations (relatively to the means) associated with choice characteristics.

4.2 IMPLICIT PRICES

In order to provide a better insight into the consumers' preferences we now turn to calculating their WTP for the characteristics of a mobile phone plan. These are calculated as marginal rates of substitution between the attribute levels and the on-net price, and additionally expressed in terms of an additional monthly payment.⁹ The results are provided in Table 3.

⁹ For a reference, the mean mobile phone bill in the sample was close to 60 PLN.

Table 2. The RPL model results (standard errors presented in parentheses)

Variable	Mean	Standard deviation
<i>SQ</i>	1.3809*** (0.2265)	2.5223*** (0.2042)
<i>ORA</i>	-0.1023 (0.2326)	0.7631*** (0.2399)
<i>TMB</i>	-0.2374 (0.2524)	1.4669*** (0.1655)
<i>PLU</i>	-0.0204 (0.2532)	1.1948*** (0.1996)
<i>PLA</i>	-0.0806 (0.2535)	1.5879*** (0.1375)
<i>NUM_KEEP_R</i>	1.1124*** (0.0795)	1.3751*** (0.0826)
<i>NUM_KEEP_B</i>	1.6619*** (0.2947)	2.6110*** (0.7153)
<i>P_ON</i>	-4.6948*** (0.2256)	4.3261*** (0.2615)
<i>P_OFF</i>	-4.0543*** (0.2004)	3.6132*** (0.2364)
<i>FF</i>	0.9339*** (0.1218)	1.9176*** (0.2019)
<i>OTH</i>	0.1048 (0.1131)	1.5221*** (0.2794)
Model characteristics		
Log-likelihood	-11,643.0189	
McFadden's pseudo R ²	0.2362	
AIC/n	1.9345	
<i>n</i> (observations)	12,060	
<i>k</i> (parameters)	22	

***, **, * Significance at 1%, 5%, 10% level

The calculated WTP measures show that respondents would be willing to, on average, pay an additional 4.22 PLN per month in order not to have to change their mobile phone operator, and a new offer would have to be at least an additional 4.69 PLN (regular users) or 6.36 PLN (business users) better if they had to change their mobile phone number. The price premiums

for brands of the mobile phone operators are not statistically different from each other, as indicated by overlapping confidence intervals. Finally, having 100% of friends and family using the same operator is worth an additional 4.22 PLN per month, while the value of increasing the share of other users is not statistically different from 0.

Table 3. WTP for a new mobile phone plan characteristics [PLN]¹⁰

WTP for:	Expressed as an increase of the on-net price		Expressed as an increase of a monthly bill	
	WTP (s.e.)	95% c.i.	WTP (s.e.)	95% c.i.
<i>SQ</i>	0.16 (0.04)	0.09 – 0.24	4.22 (0.97)	2.37 – 6.17
<i>ORA</i>	0.00 (0.03)	-0.07 – 0.06	0.00 (0.87)	-1.73 – 1.66
<i>TMB</i>	-0.01 (0.04)	-0.08 – 0.07	-0.18 (0.97)	-2.11 – 1.69
<i>PLU</i>	0.02 (0.04)	-0.05 – 0.09	0.51 (0.95)	-1.37 – 2.35
<i>PLA</i>	0.01 (0.04)	-0.06 – 0.09	0.30 (0.98)	-1.62 – 2.21
<i>NUM_KEEP_R</i>	0.18 (0.01)	0.15 – 0.21	4.69 (0.38)	3.94 – 5.44
<i>NUM_KEEP_B</i>	0.25 (0.05)	0.14 – 0.34	6.36 (1.31)	3.75 – 8.93
<i>FF</i>	0.16 (0.04)	0.09 – 0.24	4.22 (0.97)	2.37 – 6.17
<i>OTH</i>	0.00 (0.03)	-0.07 – 0.06	0.00 (0.87)	-1.73 – 1.66

5 DISCUSSION AND CONCLUSIONS

We have applied discrete choice experiment to model subscribers (stated) choices of telecommunication services offered by infrastructural mobile network operators in Poland.

¹⁰ 1 PLN \approx 0.25 EUR \approx 0.33 USD

Our main objective was to identify switching costs and network effects and measure their monetary value with implicit prices obtained from estimation of random utility model.

Although price of calls is the most important factor for subscribers, our results confirmed the importance of two types of switching costs related to number portability and status quo inertia. We have also found confirmation of network effects in mobile communications.

The monetary valuation of mobile number among residential customers in Poland equals an equivalent of 14 eur in annual terms. This result is in line with other estimations undertaking similar methodology (i.e. random utility model) for Korea ([Lee, Kim et al. 2006](#)) and Japan ([Nakamura 2008](#)). As expected, subscribers running small enterprises have substantially higher valuation (19 eur) of their phone number. Network effects play an important role in service valuation which discourages from switching. After introduction of number portability, operators started to offer on-net discounts to utilize network effect as a new way to protect their market shares.

We have found a strong status quo inertia effect which reflects all source of uncertainties associated with switching to a new operator and new service. Interestingly this effect does not contain brand loyalty, which has been controlled for separately and occurred to be insignificant. In future research we will focus our attention on heterogeneity of preferences to bring more insight into socio-demographic and calling profile characteristics of subscribers which influence valuations of switching costs.

We conclude our research with recommendation for regulatory policy to reduce uncertainty associated with changing operator by ensuring service and platform compatibility and reducing tariff complexity. In light of our results we recommend tariffs to be non-discriminatory so that operators are unable to utilize network effects in a way which discourages switching behavior.

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