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**SWITCHING COSTS AND NETWORK  
EFFECTS – HOW MUCH DO THEY REALLY  
MATTER IN MOBILE  
TELECOMMUNICATIONS?**

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## **Switching Costs and Network Effects – How Much Do they Really Matter in Mobile Telecommunications?**

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### **Abstract**

Our study focuses on the identification and the measurement of switching costs and network effects in mobile telecommunications. Although these two phenomena create similar consumer lock-in mechanisms, there are no empirical studies that integrate them into one model of subscriber's behavior. Our study fills this gap by applying stated preference valuation methods to a representative sample of individual mobile phone users in Poland. We find that number portability can be attributed to only approximately 50% of the total switching costs associated with changing either the provider or the service and the remaining part is associated with status quo inertia. Additionally, we show that because network effects play an important role in service valuation, they lead to strengthening the lock-in mechanisms even further. Our study provides the first empirical measurements of the relative importance of these simultaneous effects and provides the estimates of their monetary value.

### **Keywords:**

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

### **JEL:**

L1; L86; O3

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# 1 INTRODUCTION

Switching costs attract significant 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 are several sources of switching costs, including SIM locking policy, number portability, platform compatibility, and brand loyalty; they constitute different generic categories (contractual costs, compatibility costs, or uncertainty costs). Number portability is likely the most studied issue in empirical research on switching costs in telecommunications. It has been analyzed using various datasets and modeling approaches, utilizing different sets of control variables and different objectives focusing on identification, measurement, and implications for market competition.

This paper focuses on estimating the monetary value of number portability and compares it with the monetary equivalent of the total disutility associated with switching telecommunication operators. By applying the stated preference valuation method, namely the discrete choice experiment, we are able to control for mobile operator exogenous differences, particularly for network effects (external benefits generated by other subscribers in the same network, such as on-net discount prices). We argue that the difference in exhibited network effects between operators can be an additional source of switching costs, in addition to the costs associated with discontinuity of service or changing mobile phone numbers. Although switching costs and network effects create similar lock-in mechanisms, to the best of our knowledge there are no empirical studies that integrate both phenomena into one model of subscriber behavior. Our study fills this gap.

The paper is organized as follows. In the next section, we briefly review the relevant literature. In section 3 we describe the structure of the mobile phone market in Poland, where

our empirical study was conducted, and present the design of our study and characterize the sample. In section 4 we present the model specifications, the estimated results, and resulting implicit prices of the attributes of a mobile phone plan. The last section provides a summary and conclusion.

## 2 LITERATURE REVIEW

Switching costs and network effects have been popular topics in industrial organization for over three decades. Both phenomena are still extensively studied in various empirical applications and continue to receive attention from regulators concerned with competition policy. Switching costs can be defined as real or perceived costs that are incurred when changing suppliers but which are not incurred by remaining with the current service provider ([Padilla et al., 2003](#)). They create economies of scale by repeat purchasing and incentivizing customer loyalty, which thereby leads to an increase in the firm's market strength. Network effects, on the other hand, are positive externalities that arise due to horizontal compatibility between network nodes.

Early theoretical contributions from [Katz et al. \(1985\)](#), [Farrell et al. \(1985\)](#) and [Klemperer \(1987\)](#) treated both of these phenomena separately. Most empirical work with applications to various fields followed the same path. However, even though these effects are different in nature, they have similar consequences for market competition and consumer lock-in ([Farrell et al., 2007](#)).

Overall, general reluctance to switch can be driven by various factors such as uncertainty or incompatibility ([Klemperer, 1995](#)). The main conclusions emerging from the literature indicate that switching costs usually inhibit large scale entry and make the market less

competitive and thus should be the subject of regulatory concern, especially when their nature is partly endogenous. This is especially important in the presence of strong network effects and incompatibility – they allow the largest firms to maintain market share and push the market to an artificial equilibrium ([Economides, 1996](#)). Both phenomena remain in strategic interaction because they allow large firms to mitigate the effects of lower switching costs by increasing exposure of their customers to network effects [Shi et al. \(2006\)](#)

In the context of telecommunications, switching costs have been analyzed in numerous papers that focused mainly on number portability. [Viard \(2007\)](#) showed that the introduction of 0-800 number portability in the US reduced wholesale prices by 4.4%. [Lyons \(2010\)](#) used panel data from several countries to estimate a 7% price reduction resulting from number portability; he argued that mobile phone number portability is effective only if porting time is less than 5 days. Two interesting studies estimated monetary value of number portability for Korea ([Lee et al., 2006](#)) and Japan ([Nakamura, 2008](#)) at approximately 10 EUR; they did not control for network effects, however. [Nakamura \(2010\)](#) applied the discrete choice experiment to model portability of content and handsets across service platforms of different operators. [Grzybowski et al. \(2011\)](#) used individual panel data to analyze subscription choices for Portugal. They showed that in explaining actual customer choices and market shares, the role of switching costs is more important than price mediated network effects.

Network effects in telecommunications have also been extensively studied. Most notably [Liikanen et al. \(2004\)](#) found positive direct network effects between analogue and digital generations of mobile phones as well as within the 2G generation of mobile phones. [Doganoglu et al. \(2004\)](#) as well as [Grajek \(2007\)](#) found evidence of 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 et al. \(2011\)](#)

and [Sobolewski et al. \(2012\)](#) showed that scale and scope of this impact may depend on many market- and user-specific factors which include technology, on-net price discounts, the structure of subscriber usage profiles, and network distribution of their most frequently called parties among many other factors.

Our work contributes to the existing empirical literature on switching costs and network effects in mobile telecommunications markets by investigating these two effects simultaneously. In what follows, we apply discrete choice modeling techniques to consumers' stated preference data and estimate the monetary value of the following: (i) total switching costs, while separately including number portability and (ii) network effects. We provide insights into the nature of network effects, show where they are located and what their importance is in comparison to number portability and total switching costs (which can be called status quo inertia). To our knowledge, this is the first empirical attempt to identify and measure different mobility barriers in mobile telephony while explicitly controlling for different switching costs sources and network effects as different sources of consumer lock-in.

### 3 EMPIRICAL STUDY

Researchers in economics have two main data sources for analysis of consumer preferences – revealed and stated preference data. The former refers to situations where choices are observed in real markets and in real market situations. Conversely, stated preference data refers to situations where choices are hypothetical although typically made under incentive-compatible conditions. The use of stated-preference data is currently a fast-growing technique used in a broad range of fields, including the economics of transportation, environment,

health, marketing, and policy ([Carson, 2012](#); [Hess et al., forthcoming](#)). It makes it possible to elicit consumers' preferences for new goods, as well as preferences for existing goods with new attributes that are not necessarily available on the market or for which market data are missing. Importantly, the stated preference methods allow for the systematic and simultaneous study of the influence of multiple factors that influence choice behavior.

One of the most widely used stated preference methods is a discrete choice experiment ([Ben-Akiva et al., 1985](#); [Louviere et al., 2006](#); [Train, 2009](#)). Potential consumers are asked to make choices from mutually exclusive sets of alternatives in a hypothetically constructed scenario. In each choice situation, the choice alternatives are described in terms of different levels of attributes (characteristics) which describe the good in question ([Lancaster, 1966](#)). By observing respondents' choices in the choice situations, the effects of the attributes on the choices can be derived. In essence, this allows for estimating parameters of consumers' utility functions (i.e., to formally model their preferences) which makes it possible to simulate their market behavior, calculate welfare changes in case a new product is introduced, and estimate respondents' willingness to pay (implicit prices) for each level of each attribute.

In the following text, we present the results of a discrete choice experiment study conducted on a representative sample of consumers in Poland in 2013. Our study focuses on the identification and the measurement of switching costs and network effects in mobile telecommunications. Both of these phenomena are integrated into one experimental design, and thus their marginal effects explicitly controlled for. This provided unique insights into subscriber behavior and the sources of consumer lock-in in particular.

### 3.1 OVERVIEW OF POLISH MOBILE TELECOMMUNICATIONS MARKET

Polish mobile telecommunications market is now at full maturity, with SIM-card penetration at approximately 140%. Of the four major operators in Poland, three are early GSM incumbents<sup>4</sup> while the fourth entered the market years later at the early stages of UMTS deployment.<sup>5</sup> At the end of 2012, the three incumbents held dominant positions as they collectively controlled 82% of the market with almost equal market share among them. However, their dominance weakened as the fourth major entrant managed to establish 16% market share ([UKE, 2012](#)).

Since 2002, the incumbent operators have been offering 3G services with similar network coverage. In 2005, the Polish telecommunications regulatory board (Office of Communications, UKE) granted the fourth UMTS license to a new entrant – Play Mobile. Play started its 2G operations in 2007 under a national roaming agreement with Polkomtel and 3G services in its own UMTS network. At that time, entry into the telecommunications market was a challenge due in large part to the high market penetration of the incumbents who took advantage of high switching costs due to complicated number portability procedure and strong network effects, which protected their existing subscriber bases. As a result, by 2010 Play managed to only build a market share of 5% despite having subsidized its customer base heavily, which resulted in losses. The competitive situation has changed substantially in the last two years, however, mainly due to the facilitation of number portability procedures,

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<sup>4</sup> These are: PTK Centertel (Orange), PTC (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; it launched 1G telephony under NMT-450i in 1991 and GSM telephony in 1998. PTC (full subsidiary of T-Mobile) and Polkomtel (established jointly by Vodafone and a number of large Polish state-owned companies, and recently sold to investment fund controlled by a Polish businessman) started to offer GSM services in 1996.

<sup>5</sup> There are numerous virtual mobile network operators in the Polish market, however, their importance is negligible (1.3% share in SIM cards).

which, together with the achievement of subscriber critical mass, put Play on a fast expansion path. Currently, Play has a 16% market share and is experiencing upward trends in adoption. This late entrant is outperforming all three competitors with respect to net inflows of new subscriptions as well as switching customers by offering simpler and more attractive tariff plans.<sup>6</sup>

From the beginning, UKE supported the network expansion of the late entrant with asymmetric mobile termination rates (MTR). Originally, the asymmetry in favor of Play was more than 200%; however, both MTR levels and their asymmetry have gradually decreased since then. In January 2013, all interconnection rates have been equalized and further reduced to a current level of 0.04 PLN per minute.<sup>7</sup>

This brief market overview indicates the importance of switching costs and network effects on the entry and competition between mobile telecommunications companies. One of the objectives of this study is to investigate whether the existence of both phenomena is reflected in the individual-level preferences of subscribers.

### 3.2 DEVELOPMENT OF THE STATED PREFERENCE SURVEY

To understand consumers' preferences of mobile phone plan characteristics, we designed a discrete choice experiment study. Such data are usually collected in the form of a survey that is administered to a sample population. The questionnaire typically starts with some general introductory questions and collects status-quo information – in our case, questions referring to the current use of a mobile phone. Next, it introduces a hypothetical scenario and the choices

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<sup>6</sup> For example Play was the first to recently introduce plans with unlimited M2F and M2M calls for a fixed fee, forcing others network operators to respond accordingly.

<sup>7</sup> Which is equivalent to 1 euro cent (1 PLN  $\approx$  0.25 EUR  $\approx$  0.3 USD).

that are about to follow; the choice alternatives, attributes, and their levels are described. The respondent is then asked to review the choice situations and select the alternative that he or she prefers the most from those presented. In the last part of the questionnaire, the respondent's socio-demographic characteristics are collected.

Our study was aimed at investigating factors that influence the choice of a mobile phone plan. Therefore, we presented each respondent with a choice of four new mobile phone plans, each hypothetically provided by one of the four major operators. Additionally, each respondent had an option of remaining with his or her current mobile phone plan. The choices were hypothetical, so we requested that respondents disregard any penalty fees that can apply when they prematurely terminate their current agreement.

Each of the new mobile phone plans was described with a set of attributes that we selected through a process of extensive qualitative pre-testing (focus groups, verbal protocols) to make sure they remain significant and understandable to consumers. The attributes and their levels were carefully explained to respondents. They were asked to assume that the alternatives were exactly the same with respect to any characteristics that were not explicitly listed in the choice situations (e.g., the price of a text message). The choice experiment design consisted of 6 attributes. These were as follows:

- (1) A brand name of the mobile operator's network.<sup>8</sup>
- (2) The possibility to port one's current number.
- (3 & 4) The average on-net and off-net price of a call.<sup>9</sup>
- (5 & 6) The size of the 'family and friends'<sup>10</sup> and 'other people'<sup>11</sup> in the same network.<sup>12</sup>

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<sup>8</sup> 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 operators on the Polish market: Orange, T-Mobile, Plus and Play.

<sup>9</sup> Operators have only recently started to offer flat rate plans after substantial decrease and a newly introduced symmetry in MTRs. The majority of subscribers are still subject to price discrimination based on call destination.

The levels of the attributes, particularly on-net and off-net price and the share of ‘family and friends’ in the same network, reflected the characteristics observed in preliminary qualitative analysis. They are summarized in Table 1.

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

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

In our study, each respondent was faced with 12 choice tasks, each consisting of 4 ‘new plan’ alternatives and additionally, a ‘status quo’ alternative. Each alternative was described with the six attributes, specified above. The combinations of attribute levels presented in each of the choice tasks (i.e., the experimental design) were selected in a Bayesian efficient way

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<sup>10</sup> The group was distinguished based on the respondent’s subjective emotional relation with the group; it was defined as all persons with whom the respondent maintains regular contact, such as family, friends, acquaintances, and relatives.

<sup>11</sup> The group comprised all the other people whom a respondent contacts irregularly, such as shops, offices, and distant friends, or whom she or he does not contact at all but are still connected to the same network. This attribute was basically equivalent to each operator’s customer base.

<sup>12</sup> Calls to these 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 of network effect can also be found in [Birke et al. \(2005\)](#) and [Sobolewski et al. \(2012\)](#).

([Ferrini et al., 2007](#); [Scarpa et al., 2008](#)), i.e., to minimize the determinant of the AVC matrix of the parameters (*D-error*) given the priors on the parameters of a representative respondent's utility function, which were derived from a pilot survey. An example of a choice card shown to respondents is given in Figure 1.

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	current	new	current	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%
'Others' in the same network	75%	50%	25%	50%
<b>Your choice</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Now compare these offers with your current plan.  
 Assuming all the non-listed attributes remained the same, tick this box if you prefer your current plan to all of the above offers.

The main survey was conducted on a country-wide random sample of 1,005 individual subscribers to Polish mobile phone operators. This resulted in 12,060 choice observations because each respondent was faced with 12 choices (consisting of 5 alternatives). The sample was representative, so our empirical findings and the estimated implicit prices of the choice attributes in particular can be generalized to the population of individual mobile phone users in Poland.

### 3.3 CHARACTERISTICS OF THE MOBILE PHONE USE IN THE SAMPLE

Almost all of our respondents had a mobile phone operated by Orange (28%), Play (26%), Plus (24%) or T-Mobile (21%). The remaining 1% were subscribers of small virtual mobile operators. These results may differ from the overall market shares because our survey only focused on individual private users. In particular, Play has a substantially larger share in the individual users segment than in the business segment, which is primarily targeted by Plus and T-Mobile. This difference can be explained by the presence of switching costs and network effects which cause historical adoptions to influence future market structure – adoptions evolve from high willingness-to-pay subscribers in the beginning to low value subscribers in the maturity phase. Consequently, a late entrant cannot gain enough high-demand business subscribers, as they have been already captured by the incumbent operators. More generally, this indicates that the demand for telecommunications services is differentiated and that operators introduce strategies that target different segments of the market.

According to the survey, the price differentiation between the operators was relatively small. Play was declared by its users to be (effectively) the cheapest operator, with average 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’, compensating for a negative network effect by offering the newcomers off-net prices at the incumbents’ on-net levels.

Almost 58% of respondents were subscribers to the postpaid system. Daily outgoing voice connections averaged 38 minutes (26 vs. 41 minutes, for prepaid and postpaid plans,

respectively). The average monthly bill for all telecommunication services (voice, data, text, multimedia messages) was 58 PLN.

Interestingly, switching mobile phone providers was relatively common among our respondents. Over half of the respondents in the sample (53%) changed mobile phone operators at least once, and one third (36%) changed at least twice. Those who switched usually ported their numbers to a new operator.

The usage profile of our sample indicated that the vast majority of calls are made to and from a relatively small number of people (on average 10 persons) constituting the ‘family and friends’ group, as it was defined in the survey. The median share of such connections in total time of outgoing calls is above 70%.<sup>13</sup> Not surprisingly, with the presence of discriminatory pricing we observed a tendency of social circles to concentrate within the same operator. Half of the respondents reported that at least 50% of their ‘friends and family’ use the same mobile services that they do.

Finally, we note that there were 84 active entrepreneurs in our sample who used their mobile phones for regular business contacts. This group of subscribers can be expected to have different demand characteristics and different valuation of number portability compared to the individual subscribers ([Ofitel, 1997](#)). Indeed, entrepreneurs used mobile services more intensively and paid higher bills. They were less concerned with the share of ‘friends and family’ in the same network. However, we found that entrepreneurs were more sensitive to number portability; 98% found this factor important or very important in changing service providers, in comparison to the 92% for the rest of the sample. We investigate this preference heterogeneity further in the next section.

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<sup>13</sup> Interestingly, neither intensity of calls nor the size of this group differed across mobile operators.

## 4 RESULTS

In this section, we use the discrete choice experiment data to formally model respondents' utility functions, i.e., to quantify the extent to which each attribute influences choices and determine on what terms they are willing to trade one attribute for another. In addition, we calculate respondents' willingness to pay, i.e., the rate at which they are willing to exchange their money for the changes in the attribute levels.

### 4.1 ECONOMETRIC MODEL

Formally, discrete choice modeling 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:

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

where  $\boldsymbol{\beta}$  is the vector of parameters,  $\mathbf{x}$  is the vector of the levels of attributes specific for the consumer and the alternative, and  $\varepsilon$  is the random component, stemming from the inability to observe all of the important characteristics of 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 with the following convenient closed-form expression of the probability of choosing alternative  $j$  from a set of  $J$  available alternatives ([Greene, 2011](#)):

$$P(j|J) = \frac{\exp(\boldsymbol{\beta}'\mathbf{x}_{ij})}{\sum_{k=1}^J \exp(\boldsymbol{\beta}'\mathbf{x}_{ik})}. \quad (2)$$

The state-of-the-art DCE models allows us 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  $-\beta_i \sim f(\mathbf{b}, \Sigma)$ , where  $\mathbf{b}$  is the vector of the mean values of parameters in a population and  $\Sigma$  – their variance-covariance matrix. Although each consumer has specified 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, avoids some of the rigid assumptions of the MNL model ([Train, 2009](#)).

## 4.2 ESTIMATION RESULTS

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

$$\begin{aligned}
 U_i = & \beta_{SQ}SQ + \beta_{ORA}ORA + \beta_{TMB}TMB + \beta_{PLU}PLU + \beta_{PLA}PLA \\
 & + \beta_{NUM\_R}NUM\_KEEP\_R + \beta_{NUM\_B}NUM\_KEEP\_BIZ + \beta_{P\_ON}P\_ON, \quad (3) \\
 & + \beta_{P\_OFF}P\_OFF + \beta_{P\_OFF}P\_OFF + \beta_{FF}FF + \beta_{OTH}OTH + \varepsilon_i
 \end{aligned}$$

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,
- $\beta$  – parameters associated with respective variables.

Because one of the alternatives was the respondent's status quo mobile phone plan, we included the self-reported characteristics of the SQ alternative in the estimation. As such, the interpretation of the parameter associated with the SQ is the additional utility a respondent derives from staying with his or her current plan after all of the differences in observed attributes, including keeping the current number, are controlled for.

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

The results 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 of the other differences between mobile phone operators. The possibility of keeping one's 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 one's number. As a result, even if consumers are allowed to keep their numbers for free, one might still expect that substantial switching costs exist, related to uncertainty about quality of service or platform compatibility ([Lee et al., 2006](#)).

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

<b>Variable</b>	<b>Mean</b>	<b>Standard deviation</b>
<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)
<b>Model characteristics</b>		
Log-likelihood	-11,643.0189	
McFadden's pseudo R <sup>2</sup>	0.2362	
AIC/ <i>n</i>	1.9345	
<i>n</i> (observations)	12,060	
<i>k</i> (parameters)	22	

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

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

Not surprisingly, on-net and off-net price were significant explanatory variables that 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 indicates yet again that mobile telecommunications is an industry with very significant network effects.

Finally, we note that the results indicate the presence of 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.

### 4.3 IMPLICIT PRICES

To provide a better insight into 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 are additionally expressed in terms of an additional monthly payment.<sup>14</sup> The results are provided in Table 3.

The calculated WTP measures show that respondents would be willing, on average, to pay an additional 4.22 PLN per month not to have to change their mobile phone operator. Additionally, 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 significantly 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 significantly different from 0.

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<sup>14</sup> For a reference, the mean mobile phone bill in the sample was close to 60 PLN.

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

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 SUMMARY AND CONCLUSIONS

This study empirically investigates the effects of two phenomena: switching costs and network effects, which can both lead to consumer lock-in in the mobile telecommunications market. By utilizing stated preference data collected via a carefully designed discrete choice experiment conducted on a representative sample of a mobile phone users in Poland, we were able to model consumers' preferences, examine the strength of each effect, and measure its monetary value.

We found that although average prices of on-net and off-net calls are an important factor in choosing one's mobile phone plan, there are other factors that greatly influence the choice. These are (1) switching costs, related to number portability and status quo inertia, as well as

(2) network effects, mainly resulting from the presence of social groups of family and friends on the same network. Interestingly, we did not observe significant sample-level preference for any particular brand; however, we found substantial unobserved preference heterogeneity with this respect.

The monetary value of mobile phone number portability among individual customers in Poland was close to 13 EUR in annual terms. This result is in line with estimations for Korea ([Lee et al., 2006](#)) and Japan ([Nakamura, 2008](#)). As expected, subscribers running small enterprises have a substantially higher valuation of their phone number (19 EUR). Our study shows, however, that number portability can only account for approximately 50% of the inconvenience associated with changing to a new operator and new service. It is therefore clear that despite introducing free number portability, other transaction costs remain that constitute barriers to switching. Interestingly, this effect does not include brand loyalty, which has been controlled for separately and appeared insignificant.

In addition to the more direct switching costs discussed above, we found that network effects can also contribute to switching barriers. We found strong evidence that it is the share of a respondent's small group of family and friends that use the same operator, rather than the operator's entire customer base, that determines the strength of the network effect. Similar effects were earlier reported by [Kim et al. \(2003\)](#) and [Sobolewski et al. \(2012\)](#). As soon as operators offer on-net discounts, these network effects can provide an additional barrier to switch and thus strengthen the consumer's lock-in mechanism. Therefore, our results support the conclusions of [Shi et al. \(2006\)](#), who argue that the expected influence on market competition from the introduction of number portability does not necessarily depend only on porting conditions and the price for the service. Theoretically, large firms can mitigate the effects of lower switching costs by increasing the exposure of their customers to network

effects. This strategy can easily be implemented in telecommunications markets by introducing discriminatory pricing schemes.

Overall, our study investigates the importance of the two main drivers of consumer lock-in mechanisms in mobile telecommunications markets, namely the switching costs and network effects associated with on-net discounts. We show that phone number portability can account for only approximately 50% of the switching (transaction) costs associated with changing one's operator or service. Additionally, we show that network effects play an important role in service valuation and hence may contribute to lock-in mechanisms. Our study provides the first empirical measurements of the relative importance of these simultaneous effects.

We conclude with the recommendation that to reduce uncertainty associated with changing a mobile phone operator, regulatory policies should be amended to promote service and platform compatibility across providers, as well as to reduce tariff complexity. In light of our results, we recommend that tariffs be non-discriminatory so that operators are unable to utilize network effects in such a way that switching behavior is discouraged.

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