NETWORK EFFECTS AND CHOICE OF MOBILE OPERATOR IN SLOVENIA

Matej Švigelj, Nevenka Hrovatin

Introduction

Mobile telephony has been characterised by rapid changes in technology that triggered changes in the market structure. These changes have been accompanied by legislative and regulatory developments. The mobile telephony is one of the first telecommunications market segments where competition has de facto occurred. Mobile telephony was launched in Slovenia in 1996 when the first mobile operator Mobitel started to offer 2G mobile services. New companies entered the 2G market sequentially due to delays in granting 2G licences to new operators. Currently, there are four mobile operators. Two of them are network operators and two virtual network operators. The 'battle' for new customers was causing a continuous fall in prices accompanied by the ongoing growth of penetration. Despite this potential for competition, the Slovenian mobile market remains highly concentrated. One of the reasons may be the existence of network effects that played an important role in consumers' choice of mobile operator.

The aim of this paper is to empirically examine factors that users took into account when they decided which of the four mobile operators to choose in Slovenia. The literature in the field suggests that two sets of factors may have an impact on the user's choice. First are characteristics of mobile operators (number of subscribers, market share, advertising expenditure, prices) and second characteristics of the user himself (income, age, expenditure on mobile services). Theoretical and empirical studies have also shown that in addition to traditional factors of demand (e.g. price and income), network effects, could also have an important role in consumers' choice of a mobile operator. Network effects are present when the value of network increases with the number of users.

In this paper we follow this theoretical and empirical framework of the consumer's choice. We investigate the importance of operators' characteristics as well as users' characteristics in consumer's choice. Our main hypothesis is that network effects had an influence on the consumer's choice of mobile operator in Slovenia.

The paper is structured as follows. Section 1 provides a brief theoretical and empirical literature review on network effects in mobile telecommunications. In Section 2 we present the development of competition accompanied by changes in the market structure of the Slovenian mobile market, which supports the assumption that network effects may have influenced the consumers' choice of mobile operator. In Section 3 we explain the model specification. The data and their descriptive statistics are explained in Section 4, followed by the presentation of results in section 5. Findings and conclusions are summarised in section 6.

1. Theoretical and empirical background to network effects in mobile telecommunications

The basic idea of network externalities is that, as the number of users of a product or network increases, the value of the product or network to the other users changes [23].

Leibenstein [22] was one of the first to investigate markets with these characteristics. He defined the well-known bandwagon effect. Artle and Averous [1] first analysed externalities in communications, while the article by Rohlfs [27] is regarded as a seminal article on these issues. However, the role of network effects has largely been theoretically explored in many articles (e.g. Economides [7]) and a detailed investigation of the model that has been developed lies far beyond our scope here. Leibowitz and Margolis [23] stated that network effects raise two main sorts of concerns; first, they relate to the size of networks and, second, they relate to the choice of a network among competing alternatives. While the earlier literature mainly focused on the first concerns, more recent studies tend to focus on the winner among competing networks.

There are several possible sources of network effects in mobile telephony, which are described in Grajek [10]. The best known are so-called tariff-mediated network effects [21], which are induced by mobile operators via their differentiation between low on-net and high off-net prices. Blonski [3] uses the term endogenous network externalities to describe those effects. This means that a network operator which has installed a large user base is, with everything else being equal, of higher utility to new users than an operator which has not [8]. This can be explained in the following way. Assume that customers apply a balanced calling pattern, which means that the number of calls terminating in each network is proportional to their relative size. Since on-net calls are cheaper than off-net calls, a larger installed base of subscribers to a given network operator implies ceteris paribus a lower monthly bill for them [10]. Like in many other countries, this price differential also existed in the Slovenian mobile market, as the next section demonstrates.

Katz and Shapiro [16], [17] showed that the presence of network effects also holds significant implications for competitiveness and the market structure. At the firm level, network effects lead to more intense competition in the market. On the other hand, network effects tend to bring about a tendency towards a higher market concentration [21]. In fact, this is what has happened in the Slovenian mobile market. The 'battle' for new customers has been causing a continuous fall in prices in conjunction with the continuous growth of penetration, which has constantly exceeded the EU average. Yet, in spite of this potential for competition, the Slovenian mobile market remains highly concentrated.

Directly related to our research are studies by Kim and Kwon [18] and Birke and Swann [2] in which a similar research question was examined for the Korean and the UK mobile markets, respectively. They used a consumer survey to obtain the data. The main findings of Kim and Kwon [18] are that consumers prefer operators with a larger number of subscribers, with all other things being equal. Further, they showed that the intra-network call discount and quality signal effects are likely to be sources of size effects. Birke and Swann [2] also found some evidence that an individual's choice of operator is influenced by each operator's total number of subscribers, but a much stronger effect stems from the choice of operator made by the consumer's other household members.

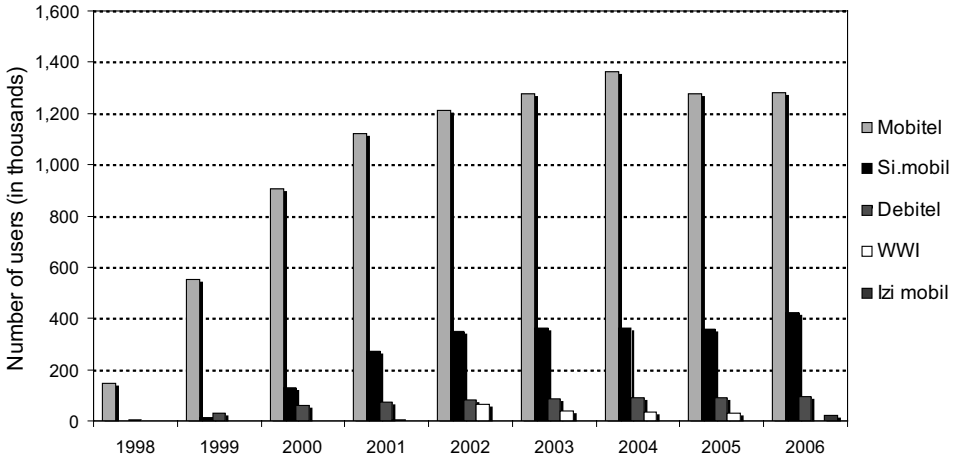
Some studies in the field of mobile telecommunications empirically examined network externalities by taking a different approach to the one mentioned above. Using a regression model with panel data, Fu [8] found that in the Taiwanese mobile market networks with a large subscriber base recruit a disproportionately greater share of new users ceteris paribus than operators with a low--penetration rate. Further, he found that the strength of the subscriber bandwagon varies in a close relationship with the price differential between on-net and off-net calls. Grajek [10] provides empirical evidence of the extent of network effects and compatibility between networks in the Polish mobile telecommunications market by using the structural model of demand. He found strong network effects, which give rise to upward-sloping demand and low compatibility despite the full interconnection of mobile telephone networks. He also concluded that endogenous network effects induced by intra-network call discounts alone are unable to explain the network effects found in his study. He also showed that the ignoring of network effects in empirical models of emerging network industries might substantially bias downwardly the estimated price elasticity of demand. Further, the results of Doganouglu and Grzybowski [5] also showed that network effects played a significant role in the diffusion of mobile services in Germany. Moreover, the results also indicated the collusive behaviour of firms following dynamic pricing policies.

2. Overview of the Slovenian mobile telephony market

In this section we present the development of competition and the current market structure of the Slovenian 2G mobile market. While the survey data considered in the empirical analysis relate to the period April 1999 - March 2004, we also describe market developments after March 2004 until the end of 2006.

In 1996 Mobitel as the first mover started to offer 2G mobile services. New companies were entering the 2G market sequentially due to a delay in the granting of more 2G licences to new operators. Before new operators entered the market

Fig. 1: Number of users by mobile operators in Slovenia at the end of the year



Source: Stergar [28] and APEK [26]

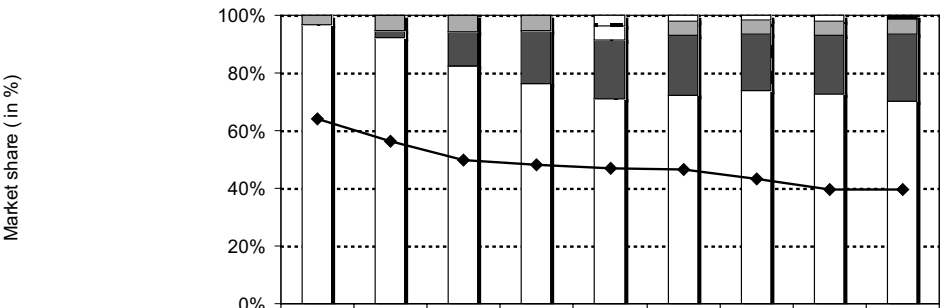
Mobitel had reduced its prices, offered subsidised handsets and differentiated users by introducing new packages. It also introduced pre-paid packages which were, like in other countries, the main driver of further mobile penetration. Mobitel also attracted the virtual network operator Debitel to offer an 'option of choice' to new users. This strategy of the company resulted in it having more than 170,000 GSM users in March 1999 by the time the second mobile operator Si.mobil entered the market (Figure 1).

With the entry of Si.mobil competition in the Slovenian mobile telephony market could truly start. In fact, the threat of competition started to work a year before when Si.mobil announced its plans to enter the market. Mobitel immediately responded with its successful strategy of cutting prices in order to attract more users. After some initial drawbacks, the competitor Si.mobil quickly began to add new subscribers, albeit at a slower rate than the incumbent operator. The competitor first expanded its market share but became stuck at around 20 % in 2002 and could not continue to grow until 2006 (see Fig. 2).

There are several explanations why Si.mobil could not expand its market share. The first reason is that it lagged behind Mobitel by more than a year in launching its pre-paid packages. By the time Si.mobil had introduced its pre-paid packages Mobitel already had more than 240,000 pre-paid users. It seems that at the start of mobile telephony the targeting of pre-paid users was an appropriate strategy for attracting users. Thus, by lagging behind in this offer Si.mobil missed the opportunity to pick up more customers immediately after starting business. The second reason was that when Si.mobil entered the market its network coverage was significantly inferior to that of the incumbent. This difference in coverage lasted for an extended period of time and was one of the main differentiating factors for potential subscribers when choosing an operator.

Further, Mobitel was a well-known and established brand name in the Slovenian mobile telephony market. This also gave it a competitive advantage over Si.mobil when attracting potential users. Another important reason that prevented Si.mobil gaining a larger market share lies in price differentiation. Both Si.mobil and Mobitel differentiated highly between their on-net and off-net call prices, which was driven by the high mobile termination prices in the competitor's networks. A caller was fully aware of in which operator's network a call was to be terminated since mobile operators had different prefix codes in their phone numbers. This was possible since number portability was not yet in effect during the observed period. Our assumption is that this large difference between the on-net and off-net prices was causing so-called 'tariff mediated ne-

Fig. 2: Market shares by mobile operators in Slovenia



	1998	1999	2000	2001	2002	2003	2004	2005	2006
Izi mobil								0.1%	1.2%
WWI				0.2%	3.8%	2.2%	1.8%	1.8%	
Debitel	3.2%	5.4%	5.7%	5.1%	4.8%	4.8%	4.8%	5.2%	5.3%
Si.mobil		2.2%	11.9%	18.3%	20.5%	20.5%	19.7%	20.4%	23.1%
Mobitel	96.8%	92.4%	82.5%	76.4%	70.9%	72.4%	73.7%	72.5%	70.3%
Leading operator in EU-15	64.0%	56.3%	49.6%	48.0%	47.1%	46.6%	43.2%	39.5%	39.4%

Source: Stergar [28], APEK [26] and EC [6]

twork externalities' as explained in Section 1. Mobitel had already acquired a large subscription base when the new operators entered the market and it was as such of higher utility to new adopters. If Si.mobil had wanted to expand its market share through lower prices, it would have had to offer lower off-net prices than Mobitel's on-net prices. Yet this was impossible given the fact that Mobitel was charging for a mobile termination in its network almost the same price as it was charging its own users for their on-net calls in several consumer packages. The end-user price of Si.mobil would in this case have had to be the same as the interconnection charge that Si.mobil needed to pay Mobitel for a call termination in its network. This would, of course, imply that the end-user price of Si.mobil would not have covered the cost of the call, which would have resulted in huge losses since most of Si.mobil calls were terminated in Mobitel's network. Therefore, it is clear that Si.mobil could not offer its users lower off-net prices than Mobitel's on-net prices [14]. On the other hand, the entry of Si.mobil triggered further price cuts in the mobile market, as shown in the figure Fig. 3. Falling prices, subsidised handsets and the introduction of pre-paid packages together led to the number of mobile users in Slovenia growing to more than one million by the end of 2000.

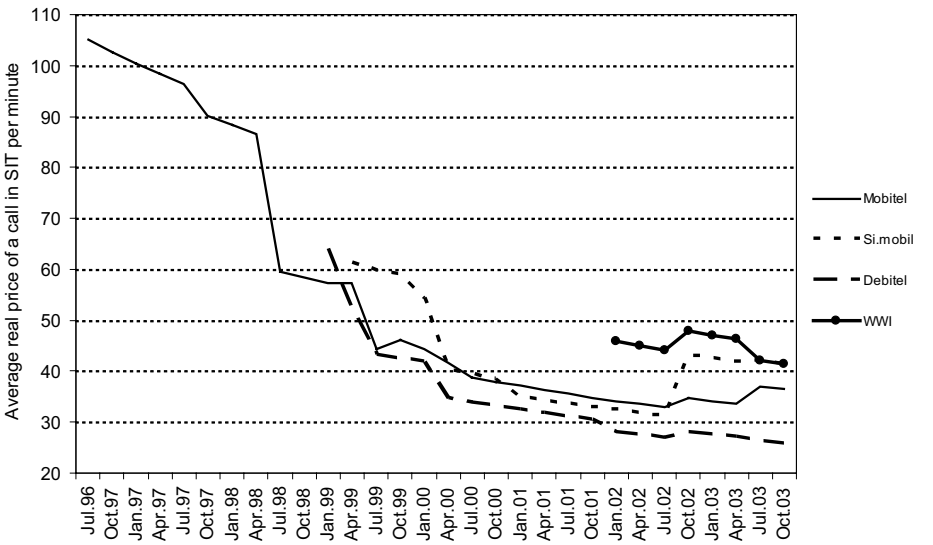
In December 2001 a third operator, Western Wireless International ('WWI', known as Vega), entered the market. Vega had a contract for national roaming with Mobitel in areas not covered by its own network so it did not face coverage problems in the initial phase like the first rival of Mobitel, i.e. Si.mobil did. Nevertheless, WWI faced a similar destiny as Si.mobil. In spite of its low on-net call prices and substantial promotions of its services, WWI could not gain a significant market share (see Figure 2). One reason for this may lie in the fact that WWI underestimated Slovenian customers in terms of their preferences for a range of services. WWI only offered basic services such as mobile voice telephony and SMS services. Other services (e.g. MMS, GPRS, EDGE) were not part of its offer. It seems that Slovenian users were more demanding and did not want to confine themselves to such a poor range of services. Therefore, with their wider ranges of choice Mobitel and Si.mobil were better options for users. In addition, the market situation at the start of WWI's operation was unfavourable to the firm. Many existing users had already signed long-term contracts with other operators in order to get subsidised handsets. This implies very high switching costs. Although switching costs lead to rents, in turn these rents induce greater competition in early stages of the

market's development [19], [20]. In fact, serious competition prevailed in the mobile market. The 'battle' for new customers was causing a continuous fall in prices and the termination-based network externalities created by the on-net/off-net price differential have definitely created a disadvantage for small operators [15].

exit from the market leaving behind the contentious issue of whether its failure was in fact driven by having a wrong business strategy or by the regulator's ineffectiveness in creating a level playing field for new rivals in the mobile telephony market.

In November 2005 a second mobile virtual network operator, Izi mobil, entered the market by

Fig. 3: Average real price of a call lasting one minute by companies in Slovenia (in SIT per minute)



Source: Gabrovšek [9]

Note: SIT is an abbreviation for the tolar, Slovenia's former currency. On 1 January 2007, Slovenia introduced the euro with a fixed exchange rate of € 1 = SIT 239.64.

It therefore came as no surprise that Vega appealed against the abuse of the monopoly power of the operator with significant market power (OSMP), Mobitel. In April 2003 it lodged a complaint with the regulator APEK (in accordance with the telecommunication legislation) and with the competition authority (in accordance with competition rules). In October 2004 Vega demanded that the government pay it EUR 173.9 million by the end of January 2005 as compensation for its ineffective regulation of the mobile markets or face court proceedings claiming EUR 337 million. Vega did not succeed in any of these claims or demands. As a consequence, in May 2006 Vega announced its immediate

launching pre-paid packages. Like Debitel, Izi mobil also uses Mobitel's network. In one year it gained a 1.2% market share. This is mostly attributable to its price strategy of charging a single tariff for all fixed and mobile networks in Slovenia at very competitive rates.

By 2006 these market developments had resulted in Mobitel being the dominant player with a 70.3% market share, followed by Si.mobil with a 23.1% market share. Debitel (5.3%) and Izi mobil (1.2%) ended up with quite low market shares in the Slovenian mobile market (Figure 2). There was still some room to acquire new subscribers since the Slovenian penetration rate at the end of 2006 (90.2 %) was below the EU average (103.2 %). In comparison with the mobile market in the EU, the Slovenian mobile market remains highly concentrated. While the leading operators

in the EU had an average 39% market share in 2006 (Figure 2) the Slovenian incumbent Mobitel held a 70% market share. As explained above, there are several reasons for this concentrated market structure. In addition to reasons that may be attributed to the market environment and business strategies of the mobile firms, the ineffectiveness of the regulator's work in the past must also be mentioned.

Pursuant to the old legislation one of the regulator's main tasks in the mobile market was the designation of operators with SMP and the control of their interconnection charges (i.e. in particular call termination charges). The Slovenian regulator imposed price control (i.e. an asymmetrical model of termination charges) with a huge delay. Earlier responses would have been needed to foster true competition among the networks. The regulator also took the wrong approach when applying EU benchmarking for interconnection charges rather than a cost-based regulatory pricing methodology, which would have better taken the substantial on-net/off-net price differentials into account. In the new EU regulatory package, transposed into the Slovenian legislation in May 2004 via the Electronic Communications Act, the regulator again imposed remedies with a delay of more than one and a half years, again something that cannot be tolerated in such a highly concentrated market [14]. Another regulatory drawback was the late implementation of mobile number portability in January 2006. The empirical findings show that number portability in the mobile industry has a significantly positive influence on competitiveness and a negative impact on prices [12], [13].

3. Econometric model specifications

In order to analyse the behaviour of consumers when they decide to choose a mobile operator, we decided to apply a multiple discrete choice model with an unordered choice set. Discrete choice models are usually based on the assumption of the decision-maker's utility-maximising behaviour [29]. For details of discrete choice models, see Green [11], Train [29] and Maddala [24].

The dependent variable in our model is the choice of mobile operator. It has three different unordered outcomes (Mobitel, Si.mobil and Debitel). In fact, it can have four different unordered outcomes but WWI was excluded from the choice set. The explanation for this is given in Section 4. The explanatory variables in our model are the mobile operators' characteristics and the characteristics of users. Since we have to include both the attributes of alternative mobile operators as well as the characteristics of individuals, the appropriate methodological choice is a conditional logit model. The model was derived from McFadden [25]. We briefly describe the model below.

For the n-th user faced with J choices the utility of choice j is:

$$U_{nj} = \beta' X_{nj} + \gamma'_j Z_n + \alpha_j + \varepsilon_{nj}. \quad (1)$$

X_{nj} is a vector of explanatory variables which describe the attributes of alternative j as faced by user n, while Z_n is a vector of explanatory variables that describe the characteristics of users. α_j is a constant that is specific to alternative j. The alternative-specific constant for an alternative captures the average effect of all factors that are not included in the model. However, since only differences in utility matter only the difference in the alternative-specific constant is relevant. The standard procedure is to normalise one of the constants to zero. In our case, we normalise the constant for Debitel alternative to zero.

Let Y_n be a random variable that indicates the choice made. In the conditional logit model the probability that user n chooses alternative (mobile operator) j is:

$$P(Y_n = j) = \frac{e^{\beta' X_{nj} + \gamma'_j Z_n + \alpha_j}}{\sum_{k=1}^{J} e^{\beta' X_{nj} + \gamma'_j Z_n + \alpha_j}}. \quad (2)$$

The characteristics of user (Z_n) do not vary over the alternatives so they fall out of the probability. Hence, the model must be modified. We create a set of dummy variables for the choices and multiply each of them by the individual characteristic. Interaction variables in the results are indicated by the first letter of the name of the mobile operator. For example, INC_m represents the product between the dummy variable for Mobitel and average monthly income (INC_n). Since a complete set of interaction terms creates singularity (the dummy variable trap), one of them must be dropped. Our arbitrary decision is to drop interaction terms for alternative Debitel from the model. This implies that this alternative acts as a referent.

In the model we use the following explanatory variables which describe the attributes of the mobile operators:

- NR_{nj} is the average cumulative number of subscribers of mobile operator *j* as faced by user *n* in the period in which he subscribed to that mobile operator. In the survey (see Section 4) a user could choose from among 10 periods between April 1999 and March 2004 in which users subscribed to a mobile operator. The values of the explanatory variables correspond to those periods. As explained in Section 2, Slovenian mobile operators have differentiated strongly between on-net and off-net call prices, which has caused tariff-mediated network externalities. On the other hand, mobile operators with a large user base can induce a bandwagon effect, as first described by Leibensten [22]. It is therefore expected that variable NR_j has a positive influence on the probability of choosing a mobile operator.
- MS_{nj} is the average market share of mobile operator *j* as faced by user *n* in the period in which he subscribed to that mobile operator. According to Katz and Shapiro [16] and Caminal and Vives [4] market share can signal quality. The higher market share of a mobile operator can be interpreted by prospective users as a signal of the higher relative quality of its mobile services. It is therefore expected that variable MSj has a positive influence on the probability of choosing a mobile operator.
- AD_{nj} is the gross value of advertising expenditure of mobile operator *j* as faced by user *n* in the period in which he subscribed to that mobile operator. All mobile operators' advertisements published in daily newspapers, magazines, TV stations, billboards and cinemas are monitored daily by a special advertising agency. Each advertisement is then rated by the official monthly list price for the specific media, whereby reductions and discounts are not taken into account. This variable is thus only an approximation of a mobile operator's advertising costs since the actual costs are not publicly available. Advertising influences the preferences of consumers and it is therefore expected that variable AD_j has a positive influence on the probability of choosing a mobile operator.
- PON_{nj} and $POFF_{nj}$ are the average on-net and off-net prices of mobile operator *j* as faced by user *n* in the period in which he subscribed to that mobile operator, respectively. Their calculation is explained in Section 3. We expected that both variables PON_j and $POFF_j$ would have a negative influence on the probability of choosing a mobile operator. Higher on-net and off-net prices would, according to the law of demand, reduce demand (i.e. in this case the choice probability).

On the other hand, the explanatory variables that describe the characteristics of users (Z_n) included in the model are:

- average monthly income (INCn);
- age (AGEn);
- average monthly expenditure on mobile services (EXPn).

There are other attributes of a mobile operator which may affect a user's choice. One of them is any handset subsidy offered. We can expect that a higher handset subsidy has a positive influence on the probability of choosing a mobile operator. However, we can expect that operators recoup their initial investment in the customer's handsets through their tariff plans. In the early stage of the development of mobile telephony, network coverage was also one of the differentiating factors for potential subscribers when choosing an operator. Unfortunately, due to data unavailability we could not include these explanatory variables in the model. Nevertheless, according to the theoretical and empirical literature the explanatory variables used here can provide a sufficient basis for explaining a subscriber's choice of mobile operator.

4. Data sources and descriptive statistics

Data on the attributes of Slovenian mobile operators were gathered from several sources for 10 mainly half-yearly periods between April 1999 and March 2004. This allows us to consider in the model the attributes of mobile operators at the time new users actually chose their operator. The number of subscribers (NR_j) was gathered directly from the mobile operators. Data on the gross value of advertising expenditure of mobile operators (AD_j) were obtained from Mediana, the Institute for Market and Media Research. Data on prices (PON_j and $POFF_j$) were partially taken from Gabrovšek [9]. Since he calculated the average prices until October 2003, we calculated the missing price le-

vels up until 2004 using the same methodology. In calculating these prices the most important post- and pre-paid packages of mobile operators were taken into account. The costs of handsets and rental charges were excluded from the calculation so only the prices of calls were considered. Descriptive statistics for the variables that describe the mobile operators' attributes are presented in Table 1. We can see that Mobitel had the highest number of subscribers, market share and on-net and off-net prices in the observed period, while Si.mobil had the highest advertising expenditures.

Data on the characteristics of mobile users were gathered through a telephone survey conducted in March 2004. Based on our questionnaire the survey and sampling was conducted by a professional agency, Ninamedia, which used the CATI method. The survey pertains to 1,200 respondents who were between 15 and 80 years old. After excluding those who did not fit the sample criteria (did not use mobile services, received their mobile phone as a present, used their company's mobile telephone, subscribed to an operator before April 1999 or did not report the period when they subscribed to an operator, average monthly income or age), 521 observations remained in the sample for estimation of the model. Since there were only 10 WWI users in the sample and the company has not operated in the market since April 1999, WWI was excluded from the analysis. Descriptive statistics for the socio-demographic variables are presented in Table 2. In terms of their average age, Debitel's users are the oldest. Further, Debitel's users have a significantly higher average monthly income and average monthly expenditure on mobile services than the users of other mobile operators.

5. Empirical results

The estimation results are presented in Table 3. We use the maximum likelihood method of estimation. Based on the likelihood ratio test (*LR*) we can reject the null hypothesis that all parameters are zero at a 0.01 level of significance. We can also reject the null hypothesis that all parameters other than the alternative-specific constant are zero at a 0.05 level of significance (see LR_c in Table 3).

The results show that the coefficients on the number of subscribers (*NR*) and market shares (*MS*) are both statistically significant and have the

Tab. 1: Descriptive statistics for the mobile operators' attributes

Variables	Mobitel		Si.mobil		Debitel	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
NR (in thousands)	948.1	276.7	217.8	128.5	63.7	18.6
MS (in %)	80	6.8	14.6	6.9	5.6	1.3
AD (in million SIT)	849.6	330.9	875.1	310.5	77.1	32.5
PON (in SIT/min)	27.5	3.3	21.49	2.3	23.2	3.2
POFF (in SIT/min)	45.1	6.8	39.3	9.9	40.7	3.4

Source: own

Tab. 2: Descriptive statistics for the mobile users' characteristics

Variables	Mobitel		Si.mobil		Debitel	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
AGE (in years)	38.47	17.1	40.83	17.0	42.74	11.0
INC (in SIT)	81,419	73,811	88,849	72,991	128,226	92,588
EXP (in SIT)	5,211	11,988	5,232	5,510	9,097	17,441

Source: own

expected signs. This means that the number of subscribers and market share have a significant positive impact on the probability of choosing a mobile operator. On the other hand, the statistically insignificant coefficients of advertising expenditures (*AD*), on-net prices (*PON*) and off--net prices (*POFF*) show that neither the cost of advertising nor the on-net or off-net price have a significant impact on the probability of choosing a mobile operator. Besides that, the coefficient of *POFF* has a positive sign, which is contrary to our expectations. One possible explanation of why variable *AD* has no influence on the choice of mobile operator is that our variable *AD* is just an approximation of advertising expenditure and might therefore have a relatively weak connection with actual advertising expenditure.

Among variables that describe the users' characteristics, the variables on average monthly income (INC_m) and (INC_s) are statistically significant. The negative signs of the coefficients of variables INC_m and INC_s mean that it is less likely that a user with a higher income would choose Mobitel or Si.mobil versus Debitel. These results can be explained by the market strategy of Debitel which, at that time, did not offer any pre-paid packages. The users of pre-paid packages usually come from lower-income groups.

Tab. 3: Econometric results

Variables	Coefficient	Standard error
NR	0.0020 ***	0.0008
MS	3.8188 ***	1.3622
AD	0.0000	0.0004
PON	-0.0749	0.0530
POFF	0.0054	0.0211
a_m	-1.0449	1.5581
INC_m	-0.0066 ***	0.0024
EXP_m	0.0000	0.0000
AGE_m	-0.0024	0.0131
a_s	1.3143 *	0.7242
INC_s	-0.0060 **	0.0026
EXP_s	0.0000	0.0000
AGE_s	0.0042	0.0138
Nr. of observations	521	
$\bar{\rho}^2$	0.2950	
$LL(\hat{\beta})$	-398.4926	
LR	347.7688 ***	
LR_c	22.5434 **	

* Significant at $\alpha = 0.10$, ** significant at $\alpha = 0.05$, *** significant at $\alpha = 0.01$.

Source: own

The findings that the number of subscribers and the market share have a positive impact on the probability of choosing a mobile operator indicate that network effects do exist in the Slovenian mobile market. Our results are consistent with the studies of Kim and Kwon [18] and Birke and Swann [2] who found evidence that an individual's choice of operator is influenced by the total number of each operator's subscribers.

Our results also resemble the market situation in the observed period. As described in Section 2, the 'battle' for new customers was causing a continuous fall in prices in conjunction with the ongoing growth of penetration. In spite of these competition trends, the leading incumbent operator's market share still exceeds 70 % while the smallest operator left the market. Such market conditions are typical of markets with network effects.

6. Conclusion

In the paper we empirically identified which factors influenced the choice of mobile users when they selected their mobile operator in Slovenia. Two set of factors were tested: characteristics mobile operators and characteristics of users. Our findings are in line with our expectations that the number of subscribers and the market share have a statistically significant positive impact on the probability of choosing the mobile operator. These in fact, confirms our hypothesis that network effects had an impact on the consumer's choice in the observed period. Our findings are particularly useful to explain the market developments in the observed period. The 'battle' for new customers in Slovenia triggered a continuous fall in mobile prices which would have generally resulted in more competitive market structure reflected in more even distribution of market shares among rivals in the market. In Slovenia this scenario did not materialise. The Slovenian mobile market remained highly concentrated in spite of severe price competition. Such market developments are typical for markets were network effects prevail.

Surprisingly, the cost of advertising, on-net prices and off-net prices did not have a significant impact on the probability of choosing a mobile operator. According to Birke and Swann [2] the reason for this may be that in the reality users had a choice among large variety of different tariff packages, while in the model the average price of mobile operators was used instead. De facto demand data (prices of different packages with the related consumption) were impossible to gather by our telephone survey as users did not remember which packages they have chosen. Also their telephone consumption (in volume terms) was impossible to obtain. Such data limitations are common in all studies of this kind.

Among characteristics of users, monthly income had a significant impact on the choice of a mobile operator. Users with higher income were more likely to select the mobile operator Debitel. This could be explained by the market strategy of Debitel which, in the observed period, did not offer any pre-paid packages. The users of pre-paid packages usually came from lower-income groups. Therefore, the lower income group users preferred Mobitel and Si.mobil as they both provided pre-paid packages which better suited their needs.

Unfortunately, the model does not allow us to explore the source of network effects which could be a consequence of the difference between the on-net and off-net prices, the bandwagon effect or quality signalling effects as suggested in the literature. The available data do not allow us to explore this issue further. It is also worth mentioning that in mature mobile markets competition is shifting from acquiring new subscribers to retaining existing subscribers and luring customers away from rival mobile operators. Accordingly, the empirical research on churning behaviour will be of particular interest for our further research.

References

[1] ARTLE, R., AVEROUS, C. The telephone system as a public good: Static and dynamic aspects. *Bell Journal of Economics.* 1973, Vol. 4, No 3, pp. 89-100. ISSN 0361-915X.

[2] BIRKE, D., SWANN, G. M. P. Network effects and the choice of mobile phone operator. *Journal of Evolutionary Economics.* 2006, Vol. 16, No 1-2, pp. 65-84. ISSN 0936-9937.

[3] BLONSKI, M. Network externalities and two-part tariffs in telecommunication markets. *Information Economics and Policy.* 2002, Vol. 14, No 1, pp. 95-109. ISSN 0167-6245.

[4] CAMINAL, R., VIVES, X. Why market shares matter: an information-based theory. *RAND Journal of Economics.* 1996, Vol. 27, No 2, pp. 221-239. ISSN 0741-6261.

[5] DOGANOUGLU, T., GRZYBOWSKI, L. *Diffusion of mobile telecommunication service in Germany.* München, 2003. Working paper. Ludwig Maximilians Universität München.

[6] EC. *Annex to the European electronic communications regulation and markets 2006.* Brussels, 2007. 12th report. Volume II, SEC(2007)403. Commission of the European Communities.

[7] ECONOMIDES, N. The economics of networks. *International Journal of Industrial Organization.* 1996, Vol. 14, No. 6, pp. 673-699. ISSN 0167-7187.

[8] FU, W. W. Termination-discriminatory pricing, subscriber bandwagons, and network traffic pattern: the Taiwanese mobile phone market. *Telecommunications Policy.* 2004, Vol. 28, No. 1, pp. 5-22. ISSN 0308-5961.

[9] GABROVŠEK, L. *Analiza gibanja cen mobilne telefonije v Sloveniji (Analysis of Mobile Telephony Price Movements in Slovenia),* Undergraduate thesis. Ljubljana: University of Ljubljana, 2004.

[10] GRAJEK, M. *Estimating network effects and compatibility in mobile telecommunications.* Discussion paper. Berlin: Wissenschaftszentrum Berlin für Sozialforschung, 2003. 39 p. Available also on: <http://skylla.wz-berlin.de/pdf/2003/ii03-26.pdf>. ISSN 0722-6748.

[11] GREENE, W. H. *Econometric analysis.* 5th ed. Upper Saddle River: Prentice Hall, 2003. 1026 p. ISBN 0-13-066189-9.

[12] GRZYBOWSKI, L. *The Competitiveness of mobile telecommunications industry across the European Union.* München, 2003. Working paper, Ludwig Maximilians Universität München.

[13] GRZYBOWSKI, L. Regulation of Mobile Telephony across the European Union: An Empirical Analysis. *Journal of Regulatory Economics.* 2005, Vol. 28, No 1, pp. 47-67. ISSN 1573-0468.

[14] HROVATIN, N., CIBIC, D., ŠVIGELJ, M. Competitiveness and regulatory implications of the mobile telephony market in Slovenia. In: Lu, T., Yan, X., Liang, X. (ed.). *Information communication technology (ICT): opportunities and challenges for telecommunications.* Beijing: China Institute of Communications, 2006.

[15] HROVATIN, N., CIBIC, D., ŠVIGELJ, M. Slovenian communications market: why is the incumbent still so dominant?. In: Kittl, J. (ed.). *Telecommunications markets in Central and South Eastern Europe: market developments and regulatory frameworks,* Köln: Lohmar, 2006. ISBN 978-3-89936-529-0.

[16] KATZ, M. L., SHAPIRO, C. Network externalities, competition, and compatibility. *American Economic Review.* 1985, Vol. 75, No. 3, pp. 424-440. ISSN 0002-8282.

[17] KATZ, M. L., SHAPIRO, C. Systems competition and network effects. *Journal of Economic Perspectives.* 1994, Vol. 82, No. 2, pp. 93-115. ISSN 0895-3309.

[18] KIM, H., KWON, N. The advantage of network size in acquiring new subscribers: a conditional logit analysis of the Korean mobile telephony market. *Information Economics and Policy.* 2003, Vol 15, No. 1, pp.17-33. ISSN 0167-6245.

[19] KLEMPERER, P. Competition when consumers have switching costs: an overview with applications to industrial organization, macroeconomics, and international trade. *The Review of Economic Studies.* 1995, Vol. 62, No. 4, pp. 515-539. ISSN 0034-6527.

[20] KLEMPERER, P. Markets with consumer switching costs. *The Quarterly Journal of Economics.* 1987, Vol. 102, No. 2, pp. 375-394. ISSN 0033-5533.

[21] LAFFONT, J., REY, P., TIROLE, J. Network competition: II. Price discrimination. *RAND Journal of Economics.* 1998, Vol. 29, No. 1, pp. 38-56. ISSN 0741-6261.

[22] LEIBENSTEIN, H. Bandwagon, snob and Veblen effects in the theory of customers' demand. *Quarterly Journal of Economics.* 1950, Vol. 64, No. 2, pp. 183-207. ISSN 0033-5533.

[23] LIEBOWITZ, S. J., MARGOLIS, S. E. Network effects. In: CAVE, M. E., LIEBOWITZ, S. J., MARGOLIS, S. E. (ed.). *Handbook of telecommunications economics.* Vol. 1: Structure, regulation and competition. Amsterdam: Elsevier Science B. V., 2002. ISBN 0-444-50389-7.

[24] MADDALA, G. S. *Limited-dependent and qualitative variables in econometrics.* Cambridge: Cambridge University Press, 1983. ISBN 0-521-33825-5.

[25] McFADDEN, D. Conditional logit analysis of qualitative choice behaviour". In: ZAREMBKA, P. (ed.). *Frontiers in econometrics.* New York: Academic Press, 1973. ISBN 0127761500.

[26] Post and Electronic Communications Agency of the Republic of Slovenia (APEK), Internal data, 2007.

[27] ROHLFS, J. a theory of interdependent demand for a communications service. *Bell Journal*

of Economics. 1974, Vol. 5, No. 1, pp. 16-37. ISSN 0361-915X.
[28] STERGAR, A. *Mobilcev nimajo samo še dojenčki (Only Babies Don't Have Cell Phones),* Ljubljana: Delo, 2004.
[29] TRAIN, K. E. *Discrete choice methods with simulation.* Cambridge: Cambridge University Press, 2003. ISBN 0-521-81696-3.

Matej Švigelj, Ph.D. (Corresponding author)
Teaching and Research Assistant,
University of Ljubljana
Faculty of Economics
Department of Economic Theory and Policy
Kardeljeva ploščad 17
1000 Ljubljana, Slovenia
matej.svigelj@ef.uni-lj.si

Nevenka Hrovatin, Ph.D.
Full Professor,
University of Ljubljana
Faculty of Economics
Department of Economic Theory and Policy
Kardeljeva ploščad 17
1000 Ljubljana
Slovenia
nevenka.hrovatin@ef.uni-lj.si

Doručeno redakci: 29. 10. 2009
Recenzováno: 18. 12. 2009, 9. 1. 2010
Schváleno k publikování: 1. 7. 2011

ABSTRACT

NETWORK EFFECTS AND CHOICE OF MOBILE OPERATOR IN SLOVENIA

Matej Švigelj, Nevenka Hrovatin

The purpose of this paper is to empirically identify factors that users took into account when choosing their mobile operator in Slovenia in the observed period (April 1999 - March 2004). Two sets of factors are tested with conditional logit model: characteristics of mobile operators and characteristics of users. Following theoretical and empirical literature suggesting that in addition to common factors of demand, network effects can also have an important role in consumers' choice we included them into the model assuming that they were present in Slovenia.

Data on the characteristics of mobile users were gathered through a telephone survey, while data for attributes of mobile operators directly from the operators. We find that two characteristics of operators, the number of their subscribers and their market shares, have a positive impact on the probability of choosing a mobile operator. This implies that network effects, which are present when the value of network increases with the number of users, had an influence on user's choice. These results reflect market developments in the observed period, when the 'battle' for new customers resulted in a continuous fall in prices while the Slovenian mobile market, contrary to the foreseen trends, remained highly concentrated.

Among characteristics of users monthly income has a significant impact on the choice of a mobile operator. Users with higher income were more likely to select the mobile operator Debitel, while those with lower income its rivals Mobitel and Si.mobil. Unlike Debitel the latter two provided pre-paid packages which are supposed to be more often chosen by low-income users.

Key words: *mobile telephony, discrete choice model, choice of mobile operator, network effects, Slovenia.*

JEL Classification: *D12, L13, L96.*