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## Consumer choice and local network effects in mobile telecommunications in Turkey

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# DISCUSSION PAPER

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# Consumer Choice and Local Network Effects in Mobile Telecommunications in Turkey

Mehmet Karaçuka<sup>\*</sup>, A. Nazif Çatik<sup>^</sup> & Justus Haucap<sup>†</sup>

October 2012

## Abstract

Turkish consumer survey data is used to analyze the main factors that affect consumers' choice of different mobile telecommunications networks. The analysis shows that consumers' choice is significantly affected by the choices of other consumers with whom the consumer is more likely to interact. The results show that local network effects exist and consumer characteristics have significant effects on consumer choice. This finding means that consumers are more likely to be affected by the choices of other people within their local area than by the overall size of a network. The results also suggest that local effects may outweigh macro network effects at least in Turkey.

Keywords: Mobile telecommunications; network effects; discrete choice analysis

JEL C23, L13, L96

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## 1. Introduction

Demand side externalities in network industries can give rise to major advantages for incumbent firms that enjoy large installed customer bases. As theoretical models of network effects show, network markets can easily tip so that a firm with a slightly higher market share captures all customers driving its competitors off the market. The most dramatic example may have been the case of the third mobile network operator in Slovenia, *Vega*, which exited from the Slovenian mobile market in 2006 after five years of operations, reportedly at least partly due to the aggressive on-net/off-net price differences offered by the two incumbents (Trilogy International Partners, 2009). Similarly, the collapse of two entrants in the Turkish mobile telecommunications market has been regarded as an example for a case where the winners take all customers in an unregulated market (see, e.g., Atiyas and Dogan, 2007). The aim of this paper is (a) to analyze the extent of network effects in mobile telecommunications markets in Turkey and (b) to identify other determinants of consumer choice in Turkish mobile telecommunications markets, based on data collected from a national survey conducted in 2006.

Telecommunications markets exhibit strong network externalities, leading to individual consumer demands being interdependent (see Rohlfs, 1974). While network effects can spur the adoption of telecommunications services, they also create competitive concerns. As has been shown elsewhere, in markets with interdependent demand, consumers are expected to choose the larger network to reap the benefits of network externalities so that the market may tip towards one firm (see, e.g., Katz and Shapiro, 1985, 1994). Without network compatibility, a new entrant's superior technology may not be sufficient to compete with an incumbent as the switching costs may lock-in consumers even if the incumbent has an inferior technology or service (see Katz and Shapiro, 1986; Arthur, 1989; Gandal, 2002). In order to prevent market foreclosure, telecommunications networks are typically required by regulation to interconnect with each other (see, e.g., Armstrong, 1998).

As mobile telecommunications networks are required to interconnect with each other, a subscriber of any network can call the subscribers of any other networks. However, as intra network calls (so-called on-net calls) are often charged at a lower rate than inter-network calls (so-called off-net calls), there is less than full compatibility in an economic sense even though the networks are technically compatible. Put differently, the differentiation between on-net

and off-net calls induces so-called tariff-mediated network effects (see Laffont, Rey and Tirole, 1998; Hoernig, 2007; Haucap and Heimeshoff, 2011). The magnitude of the on-net/off-net difference therefore determines the degree of economic (in-)compatibility and, thereby, also the degree of substitutability and competition between networks.

Notably though, even without tariff-mediated network externalities the size of a network can affect consumers, as network size can eventually serve as a quality signal (see Kim and Kwon, 2003) when consumers cannot distinguish the quality characteristics of competitors. Along with size effects, consumers are expected to take into account other factors such as the costs, coverage, and quality of customer service and of after sales care, the range of services (e.g., SMS, voice mail, and other value added services).<sup>1</sup> Among others, the coverage of mobile networks can be seen as a more substantial part of service provision, since calls can be completed if the area is covered by a network. Valletti (1999) argues that not only network size, but also their coverage may be viewed as a quality indicator for mobile services when customers are sufficiently mobile. However, networks will be considered homogenous in terms of coverage if most customers are located in a narrow area that is covered by all competing networks so that price competition becomes more important. Quite generally, competition via differentiated tariffs typically characterizes firm behaviour in competitive environments. It should be also noted though that the degree of price competition is also affected by the magnitude of eventual switching costs (Klemperer, 1987; Suleymanova and Wey, 2011).

This paper provides an empirical analysis of main determinants of consumer choice in the Turkish mobile telecommunications market. The roles that coverage, tariffs and consumer characteristics play for the individual choice of mobile networks are analyzed along with network effects on the local and the national level. For this purpose the next section provides an overview of other empirical studies focusing on network effects in mobile telecommunications. Section 3 then briefly summarizes the development of the Turkish mobile telecommunications market. The empirical methodology is described in section 4, before a description of the data is provided in section 5. The sixth section reports the empirical results before section 7 concludes.

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<sup>1</sup> These factors have also been examined through surveys conducted by Oftel (2003). Also see Doganoglu and Grzybowski (2007) as well as Grzybowski (2008).

## 2. Literature Overview

Apart from the theoretical contributions mentioned in section 1, there are several empirical studies analyzing network effects in telecommunications. Positive network effects are generally observed and found to be highly significant in diffusion models of mobile telecommunications. Gruber and Verboven (2001) analyze the diffusion process of mobile telecommunications services in European Union countries between 1984 and 1997 and find that, along with network effects and income per capita, countries with stronger competition also have higher penetration rates. Similar results are obtained by Gruber (2001) for Central and Eastern Europe. In another cross-country study Liikanen, Stoneman and Toivanen (2004) directly address network effects and confirm their existence. In yet another cross-country study of 32 industrialized countries, Koski and Kretschmer (2005) find that network effects had a significant impact on the diffusion of mobile telecommunications between 1991 and 2000. Similarly, Jang, Dai and Sung (2005) find evidence for strong network effects, using data on 29 OECD countries and Taiwan from 1980 to 2001. The magnitude of the network effect is shown to differ between countries though. In summary, these studies support the hypothesis that network effects positively impact on the adoption decision of a new technology, i.e., on consumers' decisions to acquire a new product or service.

Single country studies come to similar findings. Doganoglu and Grzybowski (2007) find strong network effects for Germany between 1998 and 2003. For Poland, Grajek (2010) finds that network effects are limited to each specific network and argues that this is due to the significant on-net discounts that generate operator-specific effects and lower the degree of compatibility between the networks which in turn limits the extent of market-wide network effects.

The studies that use market level data also find support for the existence of network effects in the diffusion process. Fu (2004) argues that tariff-mediated externalities play an important role in competition in the Taiwanese market. He finds that networks with a large subscriber base attract more new consumers than other networks, and the magnitude becomes larger with the price differential between on-net and off-net calls in Taiwan. However, in a cross-country study Grajek and Kretschmer (2009) find that, in contrast to consumers' adoption decisions, the usage intensity of mobile telephony exhibits decreasing network effects as late subscribers

have a weaker preference intensity for mobile telecommunications services so that additional users decrease the average usage.

In the analysis of network effects on consumer choice both industry-level and firm-level studies utilize what has been called “macro empiricism” (Greenstein, 1993), inferring individuals’ preferences from the observation of aggregate market behaviour (Fu, 2004). In the studies mentioned above, network effects are usually measured through use of lagged numbers of adoptions. This approach can be criticized on many grounds. Although it provides advantages in the absence of detailed consumer data, these studies ignore individuals’ preferences for network specific characteristics such as quality, coverage and services. Another drawback is that this methodology assumes that network effects are “global”, that is all connections or all groups are assumed to be equally valuable in a network, even though the literature on social networks and group formation proposes the opposite. For example, Chwe (2000) shows in a model of group formation that it is more reasonable to assume that each person only knows the network of his/her neighbors, but not the entire network. Individual locations are important for an individual’s identity and the affiliation to specific social networks. Hence, location based social interactions are becoming more important in the economic analysis of social interactions (Akerlof, 1997; Shy, 2001).

This paper aims to measure network effects and other determinants of adoption of a network by using individual data. Among other determinants of consumer choice, the extent of network effects is examined and it is analyzed whether an individual’s decision to join a specific network is affected by the choice of other individuals in his surroundings. For this purpose, the effects of consumer choices (a) in the entire market and (b) in the local area are examined. Hence, this is one of the first empirical studies that focus on local network effects in mobile telecommunications.

A few studies have recently started to use micro level consumer data in the analysis of telecommunications demand and consumer choice. Kim and Kwon (2003) have been the first to focus on demand-side network effects with consumer-level data, analyzing determinants of consumer choice in the Korean mobile telecommunications market. They use a conditional logit model with 775 observations which are obtained through a telephone survey. They find that network size is significant and positive, suggesting that consumers place a premium on larger networks. They also find a positive relationship between individuals’ expenditures for



mobile services and the probability of a consumer choosing a network. Firm dummies which measure network specific factors, have ambiguous significance in this study. When choice specific variables are included in the regression, the dummy variable for the incumbent firm is significant and negative. However, the dummy variable for the incumbent firm turns out to be insignificant when network size is excluded. Kim and Kwon (2003) conclude that consumers would have chosen other networks than the incumbent one once differences in service levels and network size are accounted for.

Birke and Swann (2006) analyze consumers' choice of mobile phone operator in the UK. Based on Swann (2002) they focus on the "relevant" subscribers (family and friends) within a network and disaggregate the network effects into two components. The first one is the overall country-level subscriber number of a network, and the second is the operator that other household members have chosen. Birke and Swann (2006) find evidence that the overall network size has a weak impact on consumers' choice, while network choice is affected in a much stronger way by the choices of other household members. The study also finds that socioeconomic groups matter for operator choice, using multinomial and conditional logit models. Birke and Swann (2010) have confirmed these findings in a follow-up study of three different countries (the Netherlands, Malaysia and Italy).

The question how network effects influence consumers' choice of mobile telecommunications operators has also been analyzed in a number of further survey-based or quasi-experimental papers. Based on a survey of 193 students Corrocher and Zirulia (2009) find that consumers are heterogeneous with respect to the emphasis they place on the choice of other members in their social networks. Students that care about the operator that other friends have chosen are typically more aware of their phone bill and use voice services more intensively. Haucap and Heimeshoff (2011) also analyze consumer behaviour towards tariff-mediated externalities, based on a survey of 1044 students. Their experiments show that a fair number of consumers may overestimate the savings which result from reduced on-net charges so that tariff-induced network effects can be even more important for consumers' choice decisions. Finally, Sobolewski and Czajkowski (2012) use a choice experiment to show that in the Polish mobile telecommunications market strong network effects still exist, which are related to the ratio of the consumers' social network group using the same operator and to the magnitude of on-net price discounts. Furthermore, it is shown that the degree of price competition between mobile operators is limited by non-price factors, which affect subscribers' choices. Two other recent

studies on mobile telecommunications markets that find social network effects among family members and friends are Maicas, Polo and Sese (2009) and Srinuan and Bohlin (2012).

While all of these studies yield important insights into individual decision making and social network effects, these analyses have been constrained to interactions within households and among friends, but not analyzed a wider local or regional area. In contrast, the analysis presented in this paper will focus on local or regional network effects, taking into account that operators' market shares often vary between regions. Hence, the level of network effects analyzed in the following is at the intermediate level between global network effects and family or friends-based "very local" network effects. Before this analysis is presented, however, it appears useful to introduce some key aspects of the mobile telecommunications market in Turkey.

### **3. Mobile Telecommunications in Turkey**

#### **3.1 National Market Structure**

As of 2012, three networks, Turkcell, Vodafone (formerly Telsim), and Avea (after the merger of Aycell and Aria) operate in Turkish mobile telecommunications market. There are around 63 million subscribers, and the penetration rate is 85 percent (ICTA, 2011). Although the penetration rate is low when compared to other European markets, Turkish subscribers use mobile voice services more intensively than most users in other countries. The average monthly minutes of usage (MoU) were 218 minutes in Turkey. In the UK, the comparable figure was 179 MoU, in Spain 58 MoU, and in Germany 110 MoU (ICTA, 2011).

Second generation (2G) mobile services were launched in 1994, and the two incumbent firms Turkcell and Telsim formed a duopoly until two new operators entered in 2001. This duopoly phase has been critical for the current state of the sector, as Turkcell acquired a major share of the market. The advantages of Turkcell vis-à-vis its rival Telsim have mainly been attributed to the different business strategies and to the lack of fortune of Telsim's management (see, e.g., Karabag and Berggren, 2011).<sup>2</sup> The expertise and managerial experiences of Sonera as

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<sup>2</sup>The main integration strategies of the two networks when they started operations were based on partnerships with foreign firms that had high-tech expertise. Alcatel and Siemens supplied technological infrastructure for Telsim as main foreign partners of the domestic Uzan Group while Turkcell formed a joint venture with the Finnish telecommunications operator Sonera (later TeliaSonera) and the Turkish Cukurova Group. After a short

international partner of Turkcell appeared to be more helpful for Turkcell's success than Telsim's foreign partners which mainly supplied the necessary infrastructure. Effectively, Turkcell launched services three months before Telsim and enjoyed first mover advantages. Furthermore, the operations of Telsim were suspended between November 1995 and June 1996 due to managerial fraud. The incidents created negative expectations about Telsim's long-run success, and the market started tipping faster towards Turkcell. Two more firms, Aria (a consortium of Italian TIM and Turkish ISBANK) and Aycell, which was an affiliate of Turk Telekom (the incumbent fixed-line operator), entered the market in 2001 after a government auction of new licenses. The new firms had to face a difficult economic environment though, due to an overall downturn of the economy as a result of a financial crisis that caused a 10% decrease of Turkey's GDP.

The figures in Table 1 show that Turkcell captured 65 percent of the market on average until 2005. Telsim's market share declined from about 30 percent to 20 percent between 2003 and 2005. Even though the new entrants' total market share gradually increased to 16 percent until 2005, Turkcell's long-lasting dominance is often attributed to the strong network effects in telecommunications markets (see, e.g., Atiyas and Dogan, 2007).<sup>3</sup>

[Insert Table 1 about here]

During that period, high interconnection rates also limited compatibility and competition in Turkey, as Atiyas and Dogan (2007) explain in detail. Competition among the firms concentrated on prices, especially on-net/off-net price discrimination, as the firms were rather homogenous in the types of tariffs offered, network coverage (as roaming agreements were used) and other dimensions (see Atiyas and Dogan, 2007).

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period of time, the Uzan Group took over all Telsim shares from its partners whereas TeliaSonera still holds 35% shares of Turkcell.

<sup>3</sup> Further analyses of the Turkish mobile telecommunications market and its regulation can be found in Burnham (2007), Ardiyok and Oguz (2010), Bagdadioglu and Cetinkaya (2010) and Karacuka, Haucap and Heimeshoff (2011).

### **3.2 Regional Differences**

Even though Turkcell is clearly dominant at the national level, there are important differences when regional market shares are considered. Table 2 presents the shares of three networks in geographical regions in 2006.<sup>4</sup>

[Insert Table 2 about here]

The regional market shares show that the Turkcell's dominance is strongest in the Marmara region, which is also the most populated part of Turkey. In the eastern and south-eastern parts of Turkey, Turkcell only accounts for 38 and 35 percent of postpaid subscribers, respectively. When both prepaid and postpaid subscriber numbers are jointly considered, Turkcell's market share drops to 54 percent in the Black Sea region and to 50 percent in South-eastern Anatolia. Surprisingly, the smallest operator, Avea, is the market leader in postpaid services in eastern and south eastern parts of Turkey, and Avea has a share very close to Turkcell in the postpaid market in the Black Sea region. The differences in market shares of mobile networks in different regions suggest that network effects can be local and each firm may gain advantages in different regions. In such a case, competition policy should consider defining relevant markets and dominant market positions taking local network effects into account. The significance of local effects should also lead firms to focus on creating micro level network effects, possibly by regional price and marketing policies.

In the next section the data is introduced and the model to measure network effects in consumer choice. If local network effects exist, the results would imply that network effects do not necessarily support a single firm throughout the country, but they may work for the benefit of different firms in different regions.

## **4. Methodology**

The methodology employed in this paper is based on discrete choice analysis, which has been pioneered by McFadden (1974) and which is widely used to model individual decisions. It is

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<sup>4</sup> Table 2 presents the shares according to the most recent data available to us. Own calculations are based on Turkish ICTA data.

also closely related to theoretical papers by Aoki (1995) and Brock and Durlauf (2001) and to empirical studies by Dugundji and Walker (2005) and Kooreman and Soetevent (2007). These papers identify equilibrium concepts and estimation procedures for models with social interactions and neighborhood effects. In the papers mentioned, social interactions are introduced into discrete choice models by allowing a given agent's choice for a particular alternative to be dependent on the overall share of all decision makers in the same groups that choose the same alternative (Kooreman and Soetevent, 2007):

$$S_{igk} = \gamma m_{igk}, \quad (1)$$

where  $S_{igk}$  is a social component of subscriber  $i$ 's utility function ( $i = 1, \dots, N$ ) in network  $g$  ( $g = 1, \dots, G$ ) when option  $k$  ( $k = 1, \dots, K$ ) is chosen rather than other networks, and  $m_{igk}$  is subscriber  $i$ 's expectation of other individuals' choices of the same network. The parameter  $\gamma$  reflects the effect of group behavior. A positive value signals that it is important for subscribers to follow the group whereas a negative value shows the opposite. Therefore, a random utility function ( $U_i$ ) including social group preferences can be expressed in a linear form as below (Kooreman and Soetevent, 2007):

$$U_i = U_i(V_i, S_i, \varepsilon_i) = V_i + S_i + \varepsilon_i, \quad (2)$$

where  $V_i$  is a private component and  $\varepsilon_i$  is a random utility term. The general form of the estimation equation can be written as follows:

$$y_i^* = \beta' X_i + \gamma' S_i + \varepsilon_i. \quad (3)$$

In the formulation above  $y^*$  is the latent dependent variable with known properties (Cramer, 2003),  $\beta'$  and  $\gamma'$  are the vectors of parameters of  $X_i$  and  $S_i$  to be estimated, which are the vectors of control variables and social interaction, respectively, and  $\varepsilon_i$  represents the random part of the utility function. When the residuals are independently and identically distributed

with a type I extreme-value cumulative distribution function  $F(\varepsilon_i < \varepsilon) = \exp(-e^{-\varepsilon})$ , the probability of individuals choosing  $m$  alternatives can be modeled through the following conditional logit model (Cramer, 2003):

$$Prob(Y_{ij}) = \frac{e^{\beta'X_{ij} + \gamma_j' S_j}}{\sum_{k=1}^m e^{\beta'X_{ik} + \gamma_j' S_j}}. \quad (4)$$

The multinomial logit model is a special case of the conditional logit model where the matrix of regressors contains only individual specific variables. The log-likelihood function of the model has of the following form:

$$l = \sum_{i=1}^m \sum_{j=1}^j d_{ij} \ln Prob(Y_{ij}), \quad (5)$$

where  $d_{ij}$  is a dummy variable, which is equal to 1 if an individual chooses alternative  $j$  and 0 otherwise.

## 5. Data and Definition of Variables

The data set for the empirical analysis has been obtained from a survey conducted in 2006 by the Telecommunications Authority of Turkey (ICTA) with guidance by TURKSTAT (the official Turkish Statistical Office). The data covers 2105 individuals that were randomly chosen in 61 cities in Turkey. In this survey, the subjects were asked to state their factual choices of adopted mobile networks: 61.2 % of the subjects named Turkcell; 25.8% Telsim-Vodafone and 13% Avea. The survey contains information on the respondents' demographic and socio-economic variables such as occupation, sex, age, income, education level, number of household members, and also telecommunications usage patterns such as the average monthly expenditures for mobile telephony and average traffic volumes. The survey questions also include consumers' inclinations and attitudes with respect to different characteristics of

mobile services such as quality, image, costumer services, tariffs, and promotions. Table 3 presents the levels of importance assigned by consumers to service-related factors. For example, 96.4 % of Turkcell’s customers claim that coverage is an important factor for their network choice; whereas this rate is 94.2 % and 93.1% for Telsim and Avea, respectively. Furthermore, data on tariffs and base stations is used as are the networks’ local and national market shares (called network-specific variables) as determinants of network choice. All variables are explicitly defined in Table 4.<sup>5</sup>

[Insert Table 3 about here]

[Insert Table 4 about here]

All data used in the analysis has been obtained from ICTA. Tariffs are calculated as the average of the on-net- and the off-net-calling price per minute in a standard tariff plan.<sup>6</sup> Base stations are measured as each individual network’s share of base stations in the province where a surveyed consumer resides. National market shares and local market shares of the networks are measured as the ratio of a given network’s subscriber base over the total number of consumers on national and regional levels, respectively.

## 6. Empirical Results

Equation (3) is estimated using a conditional logit model procedure with different alternative combinations of network-specific variables, applying Hausman and Small-Hsiao tests to check the IIA assumption on the error terms. In order to test how local network size affects

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<sup>5</sup> Although the survey respondents were asked to report the level of importance they assign to network-specific variables on a five-point scale, they have been categorized as binary variables (high or low level of importance).  
<sup>6</sup> The tariff variable is constructed as a weighted average, using national shares of on-net and off-net calling minutes. Other weights such as local shares and call termination shares have also been considered, but did not change the results.

consumers' choice, regional dummy variables and network shares at the province level are employed. Following previous empirical studies, national market shares are used to measure network effects at the country level.

[Insert Table 5 about here]

The estimation results are presented in Tables 5 and 6. Column 1 in Table 5 reports estimated parameters when all network-specific factors are included. According to these results, the only significant network-specific variable is the market share at the province level, whereas the national market share, the share of base stations, and tariffs are all not significant. However, because of the high correlation between the network-specific variables, the effects of network-specific variables are estimated one by one as reported in columns 6 to 9. The robustness of the parameter estimates is also checked by employing different combinations of network specific variables in the regressions as reported in columns 2 to 5. In all model specifications a highly significant and positive coefficient is found for local network effects, which means that choices of other people that live in the same area are important for consumers' choice. This finding implies that network externalities are not necessarily nation-wide, but can be local. This is quite intuitive since (a) consumers can usually better observe the choices made in their local surrounding, and (b) most mobile calls are typically still made to customers within the same local area.

With respect to individual demographic variables, being male rather than a female has a positive impact on the choice of Turkcell, while being married has a negative impact. For the choice of Telsim-Vodafone, age and education level variables have negative effects. Furthermore, Avea is more preferred among young consumers, who use voice services (minutes of usage) more than others. While the effect of individual income levels is not



significant for the choice of network, Telsim-Vodafone is found to be less preferable when mobile expenditures increase.

The results presented in Table 5 show that neither tariffs nor base stations have significant effects on consumer choice. It should be noted that according to information from ICTA all networks had coverage above 95 % at the national level at the time when the survey was conducted. Furthermore, the data cannot be used to measure eventual consumer responses to changes in coverage, as the survey was conducted at a certain point of time, and it was not repeated afterwards. This limitation unfortunately also applies for any estimate of the effects that tariff changes may have.

In order to overcome this limitation, consumer responses regarding their preferences with respect to various network and operator characteristics are utilized. Table 6 shows the regression results when stated consumer preferences are included. Although these variables do not necessarily capture the direct effects that certain network characteristics have on network choice, according to likelihood ratio test consumer preferences with respect to service characteristics are significant at the 1 % significance level. The results show that the level of importance that consumers assign to tariffs, service quality and customer services have a significant effect on the choice of network. Avea is more attractive for those consumers who assign a higher level of importance to tariffs whereas Turkcell is less. In contrast, consumers who report to highly value service quality and customer services are more likely to choose Turkcell.

[Insert Table 6 about here]

It should be also noted that regional dummy variables are also highly significant both in restricted and unrestricted empirical models presented in Table 5 and Table 6, meaning that network choice is affected by the regional location of consumers. Since tariffs do not vary across regions, another possible explanation for these effects could be regional differences in income and network coverage (the number of base stations). However, these variables have not been found to be significant for consumer choice in the regressions. The result suggests, however, that the competitiveness of the different mobile networks varies across regions in Turkey. The variation in the regional market power of operators may also be due to differences in regional marketing success or in the numbers of sales offices/agencies. Unfortunately though, there is no regional data available on marketing expenses or agencies so that this explanation has to be left unexplored for now.

## **7. Conclusion**

The theoretical literature on markets with network effects has shown that demand-side externalities can induce the market to tip towards the largest firm. Macro-level empirical studies that analyze network effects commonly use the assumption that a network's overall size matters most to consumers or, because networks are interconnected, the number of mobile consumers over all networks (global network effects). In contrast, more micro-level studies have suggested that family and friends and social networks matter more for consumer choice than the overall network size.

This study suggests that, based on Turkish micro data, country-level network size does not appear to be necessarily the main factor that determines consumer choice, once individual and regional heterogeneity are taken into account. Furthermore, network characteristics and

consumer preferences with respect to quality, coverage, tariffs, customer services and firm image also affect the choice of mobile network.

The analysis also suggests that local network effects are significant for consumer choice. This means that consumers are likely to be affected by the choices of other people within their local area. Furthermore, regional disparities exist in the adoption of network services in Turkey. Although the data limits the analysis of the underlying sources of regional effects, the analysis presented here suggests that different networks are more competitive in different regions.

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Table 1: Market Shares of Mobile Telecommunications Networks in Turkey

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Turkcell	78	68	80	76.9	68.5	69.2	69	67	67.3	67.9	67	63	60	58	56	56	54.2
Telsim	22	32	20	23.1	31.5	30.8	31	29.2	25.4	19.6	19	20.5	22.5	26	25	25	27.0
Aria	-	-	-	-	-	-	-	2.7	5.1	-	-	-	-	-	-	-	-
Aycell	-	-	-	-	-	-	-	1.1	2.1	-	-	-	-	-	-	-	-
Avea	-	-	-	-	-	-	-	-	-	12.5	14	16.5	17.5	16	19	19	18.8

Source: Data obtained from Atiyas and Dogan (2007) and Information and Communications Technologies Authority of Turkey (ICTA).

Table 2: Regional Subscriber Shares of Network Operators in Turkey

	Turkcell Prepaid	Turkcell Post Paid	Telsim Prepaid	Telsim Post Paid	Avea Prepaid	AveaPost paid	Turkcell Total	Telsim Total	Avea Total
Marmara	0.67	0.69	0.24	0.10	0.09	0.20	0.67	0.21	0.12
Ege	0.59	0.55	0.27	0.12	0.14	0.34	0.58	0.24	0.18
Mediterranean	0.61	0.53	0.30	0.12	0.10	0.35	0.60	0.27	0.14
Black Sea	0.56	0.46	0.37	0.14	0.07	0.40	0.54	0.34	0.12
Interior Anatolia	0.58	0.52	0.27	0.12	0.15	0.36	0.57	0.24	0.19
Eastern Anatolia	0.60	0.35	0.33	0.09	0.07	0.56	0.56	0.30	0.14
South-eastern Anatolia	0.52	0.38	0.40	0.15	0.07	0.47	0.50	0.37	0.13
Total	0.61	0.58	0.29	0.11	0.10	0.31	0.60	0.25	0.14



Table 3: Definition of Variables

Variable	Definition
Choice of network	Dependent variable of the model. There are three alternatives for the consumers: Turkcell, Telsim-Vodafone and Avea.
<b>1. Network-Specific Variables</b>	
Nationalshare	Market share of the chosen network at national level.
Localshare	Market share of the chosen network at level of the province.
Basestations	Share of base stations of the chosen network at province level.
Tariff	Price of one minute call in a standard tariff plan
<b>2. Regional Effects Variables</b>	
Dummy variables for the regions	
<b>3. Demographic variables</b>	
Age	Age of the respondent
Sex	Gender of the respondents: 1 for female
Marital	Marital status of the respondents: 1 for married, 0 otherwise
Education	1 if respondents completed high school or university.
<b>4. Economic Variables</b>	
Income	Average monthly income of the respondents, a classified variable ranging from 1 (less than 200 TL) to 16 (3000 TL or more)
Expenditure	Mobile carrier expenditure per month, a classified variable ranging from 1 (10 TL) to 7 (251 TL or more)
<b>5. Usage</b>	
Minutes of Usage (MoU)	Maximum duration of a call in a day; a classified variable ranging from 1 (1-15 minutes) to 4 (60 min. or more)
<b>6. Consumer Preferences</b>	
Coverage	1 if a network's coverage properties are important or very important for the respondent, 0 otherwise
Service Quality	1 if a network's service quality is important or very important for the respondent, 0 otherwise
Tariffs	1 if a network's tariffs are important or very important for the respondent, 0 otherwise
Customer Services	1 if a network's customer services are important or very important for the respondent, 0 otherwise
Social Networks	1 if being in the same network as family and friends is important or very important for the respondent, 0 otherwise
Promotions	1 if a network's promotions are important or very important for the respondent, 0 otherwise
Network Image	1 if a network operator's image is important or very important for the respondent, 0 otherwise

**Table 4: Importance of Network Specific Factors for Consumers (as Fraction of Consumers)**

	Turkcell	Telsim	Avea
Coverage	0.964163	0.942222	0.931373
Service Quality	0.950379	0.944444	0.906863
Tariffs	0.871123	0.902222	0.882353
Customer Services	0.880772	0.882222	0.833333
Social Networks	0.871123	0.884444	0.862745
Promotions	0.753963	0.795556	0.754902
Network Image	0.745693	0.706667	0.730392

**Table 5: Estimation Results I**

	1	2	3	4	5	6	7	8	9	10
<i>Network Variables</i>										
<b>Nationalshare</b>	0.0316	0.014	0.0231			0.0232				
<b>Localshare</b>	2.0828***	2.1015***		2.1287***			2.1256***			
<b>Basestations</b>	-0.2903		0.0479	-0.1364	0.165			0.2224		
<b>Tariff</b>	-0.0795				0.044				0.046	
<i>Regional Dummies- Turkcell</i>										
<b>Marmara</b>	1.4626***	1.3452***	2.5674***	1.7883***	2.959***	2.5694***	1.7717***	3.3102***	2.969***	3.342***
<b>Aegean</b>	0.9271*	0.8202*	1.5538***	1.2535***	1.937***	1.5552***	1.2382***	2.2808***	1.946***	2.31***
<b>Int. Anatolia</b>	0.9810*	0.8901**	1.7635***	1.3382***	2.174***	1.7611***	1.3323***	2.5379***	2.17***	2.55***
<b>Mediterranean</b>	1.6980***	1.5842***	3.0105***	2.0317***	3.412***	3.0117***	2.0175***	3.7701***	3.419***	3.799***
<b>Black Sea</b>	1.7212***	1.615367***	2.7101***	2.0598***	3.11***	2.7100***	2.0484***	3.4665***	3.113***	3.489***
<b>Eastern Anatolia</b>	1.6352**	1.5411**	2.8332***	1.9831***	3.244***	2.8313***	1.9773***	3.6068***	3.241***	3.621***
<b>South Eastern Anatolia</b>	1.4190**	1.2975**	2.1527***	1.7796***	2.565***	2.1553***	1.7620***	2.9368***	2.577***	2.973***
<i>Regional Dummies Telsim-Vodafone</i>										
<b>Marmara</b>	1.9846***	1.7014***	2.2747***	1.7401***	2.175***	2.2711***	1.7504***	2.3818***	2.157***	2.367***
<b>Aegean</b>	1.3698***	1.0964***	1.3996***	1.1412***	1.303***	1.3965***	1.1490***	1.5031***	1.287***	1.492***
<b>Int. Anatolia</b>	1.4958**	1.2133***	1.6296***	1.24952***	1.531***	1.6243***	1.2628***	1.7435***	1.508***	1.722***
<b>Mediterranean</b>	2.0695***	1.7852***	2.2271***	1.8177***	2.124***	2.2228***	1.8303***	2.3340***	2.103***	2.316***
<b>Black Sea</b>	2.5859***	2.2906***	3.1215***	2.32351***	3.017***	3.1184***	2.3327***	3.2240***	3.001***	3.212***
<b>Eastern Anatolia</b>	1.9171**	1.6205***	2.0670***	1.6565***	1.957***	2.0645***	1.6640***	2.1654***	1.943***	2.157***
<b>South Eastern Anatolia</b>	2.0236***	1.7156***	2.6738***	1.7584***	2.572***	2.6706***	1.7693***	2.7946***	2.555***	2.783***
<i>Demographic Variables -Turkcell</i>										
<b>Age</b>	-0.0052	-0.0061	-0.0119*	-0.0028	-0.01	-0.0119*	-0.0029	-0.0072	-0.01	-0.007
<b>Sex</b>	0.5277***	0.5216***	0.4746***	0.54119***	0.486***	0.4745***	0.5397***	0.4990***	0.487**	0.501***
<b>Education</b>	-0.9539***	-0.9524***	-0.9387***	-0.9544***	-0.938***	-0.93946***	-0.9526***	-0.9361***	-0.94***	-0.939***
<b>Marital Status</b>	-0.5426**	-0.5660***	-0.6386***	-0.4983**	-0.594***	-0.6386***	-0.4999**	-0.5412**	-0.594***	-0.539

**Table 5: Estimation Results I (Continued)**

	1	2	3	4	5	6	7	8	9	10
<i>Demographic Variables Telsim-Vodafone</i>										
Age	-0.014*	-0.017***	-0.021***	-0.017**	-0.022***	-0.017**	-0.021***	-0.02***	-0.022***	-0.02***
Sex	-0.042	-0.0464	-0.0419	-0.033	-0.033	-0.042082	-0.0327	-0.0211	-0.034	-0.022
Education	-0.5924***	-0.59513***	-0.5622***	-0.5970***	-0.563***	-0.5625***	-0.5962***	-0.5607***	-0.564***	-0.562***
Marital Status	0.1575	0.11664	-0.0314	0.1538	-0.022	-0.0316	0.1532	0.0264	-0.023	0.027
<i>Economic Variables Turkcell</i>										
Income	-0.0189	-0.01966	-0.0164	-0.0165	-0.014	-0.0164	-0.0165	-0.0119	-0.014	-0.012
Expenditure for Mobile Services	-0.0436	-0.0444	-0.0494	-0.0419	-0.048	-0.0494	-0.0421	-0.0463	-0.048	-0.046
<i>Economic Variables Telsim Vodafone</i>										
Income	-0.0328	-0.0343	-0.0426*	-0.0334	-0.043	-0.0426*	-0.0334	-0.0408	-0.043*	-0.041
Expenditure for Mobile Services	-0.0903	-0.0914*	-0.0955**	-0.0899*	-0.095**	-0.0955**	-0.0901*	-0.0934*	-0.095**	-0.093*
<i>Usage Turkcell</i>										
Minutes of Usage	-0.1801	-0.1880**	-0.2315***	-0.1691**	-0.22***	-0.2315***	-0.1696**	-0.2063***	-0.221***	-0.206***
<i>Usage Telsim-Vodafone</i>										
Minutes of Usage	0.1223	0.1117	0.0747	0.1075	0.076	0.0745	0.1218	0.0878	0.075	0.087
<b>Pseudo R2</b>	0.3487	0.3486	0.3267	0.3482	0.326	0.3267	0.3482	0.3258	0.326	0.3258
<b>Loglikelihood</b>	-1501.8967	-1502.1922	-1552.6307	-1502.9838	-1554.2781	-1552.634	-1503.0096	-1554.6586	-1554.3171	-1554.7306
<b>LikelihoodRatio</b>	1608.18	1607.59	1506.71	1606.01	1503.42	1506.71	1605.96	1502.66	1503.34	1502.51

Note: \*\*\*, \*\* and \* denotes significant at 1%, 5% and 10% respectively.

**Table 6. Estimation Results II**

	1	2	3	4	8	6	7	5	9	10	11
<i>Network Variables</i>											
Nationalshare	0.035	0.003	0.007	0.002			0.007				
Localshare	2.104***	2.132***		2.127**	2.133***			2.128***			
Basestations	-0.28	-0.242	0.103		-0.225	0.17			0.142		
Tariff	-0.153					-0.03				-0.029	
<i>Regional Dummies-Turkcell</i>											
Marmara	1.627***	1.485***	2.821***	1.48***	1.543***	3.136***	2.825***	1.523***	2.972***	3.145***	2.988***
Aegean	1.067**	0.935*	1.78***	0.93*	0.991**	2.088***	1.783***	0.972**	1.928***	2.096***	1.942***
Int. Anatolia	1.145**	1.011**	2.023***	1.025**	1.072***	2.35***	2.017***	1.069***	2.181***	2.345***	2.184***
Mediterranean	1.753***	1.61***	3.177***	1.609***	1.669***	3.499***	3.179***	1.653***	3.332***	3.506***	2.321***
Black Sea	1.815***	1.684***	2.908***	1.688***	1.74***	3.216***	2.907***	1.729***	3.056***	3.218***	3.065***
Eastern Anatolia	1.78***	1.643***	3.076***	1.656***	1.703***	3.404***	3.072***	1.7***	3.234***	3.4***	3.239***
South Eastern Anatolia	1.521***	1.375**	2.336***	1.369**	1.436***	2.666***	2.341***	1.415***	2.494***	2.678***	2.512***
<i>Regional Dummies Telsim-Vodafone</i>											
Marmara	2.028***	1.602***	2.444***	1.623***	1.606***	2.545***	2.436***	1.625***	2.454***	2.528***	2.443***
Aegean	1.378**	0.966**	1.507***	0.982**	0.97**	1.605***	1.501**	0.985**	1.516**	1.591***	1.508***
Int. Anatolia	1.511**	1.081**	1.779***	1.107**	1.085**	1.883***	1.768***	1.109***	1.79***	1.861***	1.775***
Mediterranean	2.04***	1.608***	2.324***	1.633***	1.612***	2.426***	2.315***	1.634***	2.333***	2.406***	3.345***
Black Sea	2.563***	2.14***	3.264***	2.159***	2.142***	3.356***	3.258***	2.159***	3.27***	3.341***	3.261***
Eastern Anatolia	1.945***	1.514**	2.244***	1.529**	1.517***	2.343***	2.239***	1.53**	2.251***	2.331***	2.245***
South Eastern Anatolia	1.988***	1.532***	2.764***	1.554***	1.537***	2.872***	2.757***	1.556***	2.774***	2.856***	2.766***
<i>Demographic Variables-Turkcell</i>											
Age	-0.005	-0.007	-0.011*	-0.007	-0.006	-0.009	-0.011*	-0.006	-0.01	-0.009	-0.01
Sex	0.523***	0.517***	0.467***	0.515***	0.519***	0.479***	0.468***	0.517***	0.472***	0.48***	0.474***
Education	-0.982***	-0.985***	-0.965***	-0.982***	-0.985***	-0.964***	-0.966***	-0.982***	-0.965***	-0.966***	-0.967***
Marital Status	-0.559***	-0.592***	-0.637***	-0.591***	-0.583***	-0.592***	-0.637***	-0.585***	-0.617***	-0.592***	-0.616***
<i>Demographic Variables Telsim-Vodafone</i>											
Age	-0.014*	-0.017**	-0.021***	-0.017***	-0.017**	-0.019**	-0.021***	-0.017**	-0.02***	-0.019**	-0.02***
Sex	-0.057	-0.065	-0.058	-0.064	-0.063	-0.048	-0.059	-0.062	-0.054	-0.049	-0.054
Education	-0.62***	-0.625***	-0.587***	-0.624***	-0.625***	-0.586***	-0.588***	-0.624***	-0.587***	-0.586***	-0.588***
Marital Status	0.153	0.096	-0.012	0.097	0.101	0.02	-0.012	0.1	-0.001	0.019	-0.001

**Table 6. Estimation Results II (Continued)**

<i>EconomicVariables Turkcell</i>	1	2	3	4	5	6	7	8	9	10	11
<b>Income</b>	-0.023	-0.023	-0.019	-0.023	-0.023	-0.017	-0.019	-0.023	-0.018	-0.017	-0.018
<b>Expenditure</b>	-0.045	-0.046	-0.051	-0.046	-0.046	-0.049	-0.051	-0.046	-0.05	-0.049	-0.05
<i>EconomicVariables Telsim Vodafone</i>											
<b>Income</b>	-0.035	-0.037	-0.043*	-0.037	-0.037	-0.042	-0.043*	-0.036	-0.043*	-0.042	-0.043*
<b>Expenditure</b>	-0.095*	-0.096**	-0.1**	-0.096*	-0.096*	-0.098**	-0.1**	-0.096*	-0.099**	-0.098**	-0.099**
<i>Usage Turkcell</i>											
<b>Minutes of Usage</b>	-0.186**	-0.198**	-0.235***	-0.198**	-0.196**	-0.222***	-0.235**	-0.196**	-0.23**	-0.223***	-0.229***
<i>Usage Telsim-Vodafone</i>											
<b>Minutes of Usage</b>	0.121	0.103	0.073	0.104	0.104	0.081	0.072	0.104	0.075	0.081	0.075
<i>Consumer Preferences- Turkcell</i>											
<b>Coverage</b>	0.233	0.188	0.205	0.192	0.208	0.313	0.203	0.207	0.257	0.311	0.258
<b>Tariff</b>	-0.599**	-0.614**	-0.587**	-0.616	-0.611**	0.861**	-0.586**	-0.613**	-0.578**	-0.565**	-0.576*
<b>Service Quality</b>	0.838**	0.828**	0.816**	0.831**	0.838**	-0.567**	0.815**	0.838**	0.839**	0.859**	0.838**
<b>Customer Services</b>	0.505**	0.493*	0.424*	0.49*	0.495*	0.436*	0.425	0.492**	0.429*	0.438*	0.431*
<b>Social Networks</b>	-0.286	-0.31	-0.282	-0.309	-0.305	-0.253	-0.282	-0.305	-0.27	-0.253	-0.269
<b>Promotions</b>	-0.047	-0.058	-0.043	-0.058	-0.055	-0.028	-0.043	-0.056	-0.036	-0.028	-0.036
<b>Network Image</b>	-0.003	-0.003	-0.002	-0.006	-0.004	-0.003	-0.001	-0.006	-0.003	-0.001	-0.001
<i>Consumer Preferences- Telsim Vodafone</i>											
<b>Coverage</b>	-0.177	-0.268	-0.421	-0.264	-0.26	-0.358	-0.423	-0.258	-0.397	-0.361	-0.398
<b>Tariff</b>	-0.197	-0.216	-0.241	-0.217	-0.213	-0.223	-0.241	-0.215	-0.233	-0.222	-0.232
<b>Service Quality</b>	0.508	0.446	0.444	0.45	0.446	0.453	0.442	0.449	0.442	0.45	0.44
<b>Customer Services</b>	0.454	0.434	0.425	0.433	0.436	0.436	0.425	0.434	0.428	0.437	0.429
<b>Social Networks</b>	0.079	0.04	-0.05	0.038	0.043	-0.028	-0.049	0.04	-0.043	-0.027	-0.041
<b>Promotions</b>	0.224	0.205	0.192	0.207	0.206	0.203	0.192	0.208	0.196	0.201	0.195
<b>Network Image</b>	-0.323	-0.323	-0.373	-0.328	-0.324	-0.376	-0.371	-0.328	-0.375	-0.372	-0.372
<b>Pseudo R<sup>2</sup></b>	0.3544	0.3542	0.3325	0.3541	0.3542	0.3325	0.3325	0.3541	0.3325	0.3325	0.3325
<b>Loglikelihood</b>	-1488.771	-1489.274	-1539.14	-1489.351	-1489.294	-1539.146	-1539.159	-1489.36	-1539.27	-1539.187	-1539.299
<b>LikelihoodRatio</b>	1634.43	1633.43	1533.69	1633.27	1633.39	1533.68	1533.66	1633.25	1533.43	1533.6	1533.38

Note: \*\*\*, \*\* and \* denotes significant at 1%, 5% and 10% respectively.

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