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Abstract

We investigate the factors influencing the demand for mobile voice services in Turkey using firm level data that spans from January 2009 to December 2013. Competition in the mobile telecommunication market in Turkey has become more intense as a result of the mobile number portability (MNP) service introduced in 2008 and 3G technology introduced in 2009. The intense competition not only helps to keep prices down but also supports subscriber growth. Besides prices, we believe that network effects have an impact on market growth. Approximating sales levels using subscription levels and churn rates and using revenue per minute (RPM) as a price measure, we find that while price has a significant negative impact, network effects have a significant positive impact on the demand for mobile services in Turkey. We also estimate own and cross price elasticities of firms operating in mobile telecommunication market.

JEL Classification: L9, L96

Keywords: Mobile telecommunications; network effects; price elasticity

ملخص

نقوم بالتحقيق في العوامل المؤثرة في الطلب على الخدمات الصـوتية المتنقلة في تركيا باسـتخدام بيانات على مسـتوى الشـركات تمتد خلال الفترة من يناير 2009 إلى ديسـمبر 2013. والمنافسـة في سـوق الاتصـالات المتنقلة في تركيا أصـبحت أكثر كثافة نتيجة لخدمة قابلية رقم الجوال (MNP) التى قدمت في عام 2008 وأدخلت تكنولوجيا الجيل الثالث G3 في عام 2009. والمنافســـة الشـــديدة لا تساعد فقط على خفض الأسعار ولكن تدعم أيضا نمو عدد المشتركين. إلى جانب الأسعار، ونحن نعتقد أن الشبكات لها تأثير على نمو السوق. وباستخدام تقارب مستويات المبيعات ومستويات الاشتراك واستخدام العائدات في الدقيقة (RPM) كإجراء السعر، نجد أنه في حين أن تغيير السـعر له أثر سـلبي كبير، الا أن الشـبكات لها تأثير إيجابي كبير على الطلب على خدمات الهاتف النقال في تركيا. نقوم أيضا بتقدير المرونات السعرية الخاصة وعبر الشركات العاملة في سوق الاتصالات المتنقلة.

1. Introduction

There is ongoing change and growth in the mobile telecommunication industry. Mobile operators continue to offer new services to meet customers' growing interests and demands for mobile services and to increase their market shares. One of the factors contributing to the growth of the mobile telecommunication market is liberalization. With the help of liberalization and the removal of barriers to entry, new players enter the market and competition increases. Furthermore, the availability of regulatory tools that promote competition plays an important role in the evolution of the mobile telecommunication industry. For example, mobile number portability (MNP) that allows customers to switch to other operators without changing their existing mobile phone numbers reduces customers' switching costs. Technological developments such as the introduction of third generation (3G) mobile networks and smart phones also contribute to the growth of the mobile market. 3G networks allow more rapid data transfer and enable video conferencing and face to face communication. Furthermore, the declining costs and increasing attractiveness of handsets play an important role in the growth of the demand for mobile services.

In our research, we analyze the demand for mobile services in Turkey using publicly available industry data. Turkey has been one of the fastest growing economies during the last decade and there is high growth potential and large demand for the mobile services due to the high proportion of young people in the population. However, the demand for mobile services in Turkey has not been thoroughly analyzed. Specifically, we want to analyze the impact of network effects on the demand for mobile services. As more people subscribe to mobile services, more value accrues to all (Liebowitz and Margolis 1994, Gruber and Verboven 2001).We have aggregate monthly data, which spans from January 2009 to December 2013, on voice services offered by mobile operators in Turkey. Our dataset includes subscription levels, the average revenue per user (ARPU), the average number of minutes of voice communication (MOU), and churn rates.

In this research, similar to other researchers who analyzed demand for mobile services in other countries, we adopt a discrete-choice modeling approach (Berry 1994) and use a standard aggregate nested logit model to model demand for mobile telecommunication services. In this setting, consumers make a choice whether to subscribe to a mobile service in addition to their fixed line subscriptions in the first stage, and then in the second stage they choose a mobile operator. We use the estimation procedure proposed by Berry (1994) and invert market-share equations to find the implied mean levels of utility for each choice. Our analysis of demand for mobile services shows that while there is a negative relationship between price and demand, there is a positive relationship between network effects and demand. These results are consistent with our expectations.

The paper is organized as follows. Section 2 provides an overview of related research. Section 3 discusses the Turkish mobile telecommunication market. Section 4 presents the empirical model and Section 5 describes our data sources. The results are presented in Section 6. Section 7 discusses the conclusions.

2. Literature

Empirical work on the network effects in mobile telecommunications industry, in general, either analyze the diffusion of mobile services or measure price elasticities using survey data or aggregated data on the country or regional levels.

Gruber and Verboven (2001) estimate a logistic diffusion model to analyze the impacts of government policies on the growth of the global mobile telecommunications industry. Wallsten (2003) empirically analyzes whether establishing a regulatory authority prior to privatization matters and shows that countries establishing regulatory authorities prior to privatization had a higher telecom investment and penetration rate. Kim and Kwon (2003) analyze the impact of

network size on new subscribers' choice of service providers based on consumer survey data from Korean mobile telephone industry and find that consumers prefer mobile operators with larger subscriber bases. Using both market-level data and survey data, Birke and Swann (2006) analyze the influence of network effects on consumer choice of mobile telephone operators in the UK. Using a structural demand model for mobile services, Grajek (2003) estimates the network effects on the mobile telephone industry in Poland over 1996–2001. He finds the existence of strong network effects and shows that when network effects are ignored, the demand elasticity is overestimated.

The Turkish mobile market has not been thoroughly investigated. In one of the few studies, Karacuka et al. (2011) estimate short- and long-run demand elasticities for the Turkish mobile telecommunication market using a dynamic panel data model. They use a model of Houthakker–Taylor (1970) where current consumption is just function of price and earlier demand. Atiyas and Dogan (2007) noted that incumbent firms enjoy first-mover advantage over other operators entering the market late. They qualitatively analyzed the effect of various polices used by regulation agencies in order to limit the first mover advantage of incumbent operators.

Our paper is most similar to Doganoglu and Grzybowski (2007) which analyzes the impact of network effects in the mobile telecommunication market in Germany in the period from January 1998 to June 2003. Assuming a linear utility and a linear network benefit function, they model demand for mobile subscriptions using a discrete-choice model and use the estimation strategy proposed by Berry (1994).

3. Market Overview

Currently, there are three firms operating in the Turkish Mobile Telecommunication Market. The Information and Communication Technologies Authority (BTK) reports that Turkcell is the market leader with 35.2 million customers and a 50.53 % share by December 2013. Vodafone has 19.9 million customers and a 28.61 % share, while Avea, owned by Turk Telecom, had 14.5 million users with a 20.86% share. Furthermore, Turk Telecom has a monopoly in the fixed line telecommunication market. Figure 1 and Figure 2 show the subscriber number and average revenue per user (ARPU) of operators respectively.

In July 1993, the Turkcell and Telsim signed a contract by paying 500 million USD with the government officials based on revenue sharing principle. According to this agreement, 70.1% of the revenues generated from mobile service are given to the government at that time. Revenue sharing contract are replaced by license contract in July 1998 and Turkcell and Telsim paid 500 million USD for 25 years license grant. Turkcell and Telsim (currently Vodafone Turkey) have offered mobile services over the GSM 900 network since 1994. At the end of 2005, Telsim was sold to Vodafone group for a 4.550 billion USD.

In 2001, Is-Tim, a consortium of Is Bank of Turkey and Telecom Italia, started mobile operations under the brand name Aria. At that time, Turkcell and Telsim had 10.25 and 4.56 million subscribers respectively. Later, Aycell, a Turk Telekom subsidiary, entered the market as the fourth operator. As there was an absence of regulation regarding high interconnection prices and mobile number portability service (MNP), the two companies did not compete with the other two incumbent operators. As a result, Aria and Aycell decided to merge under the name of "AveA" in 2003. Avea has offered mobile services over the GSM 1800 network

In 2008, BTK (Information and Technology Board) allowed subscribers to switch to other operators without changing their current cell phone numbers. As a result of the MNP service, the competition in the Turkish mobile telecommunication market has become more intense. After the introduction of MNP service, all three mobile operators - Turkcell, Vodafone Turkey and Avea - implemented new campaigns and tariffs to protect their customer base as well as to

attract competitors' subscribers. Turkcell, the market leader in the mobile phone market, was affected the most, as it keeps losing subscribers from the start date of the MNP service. In addition, as can be seen in Figure 5, the revenue per minute of all operators has substantially decreased from the start of MNP service.

The auction of 3G technology licenses was conducted in 2009. In this auction, the largest mobile network, Turkcell, bid 358 million euro for an A type license while Vodaphone and Avea paid 250 and 214 million euros respectively for B and C type licenses. Firms having A, B and C types of licenses operate at 45, 35 and 30 megahertz frequency respectively. The introduction of new mobile devices, such as smart phones and tablet PCs, has contributed to the success of 3G services. As a result of the adoption of these services in June 2009, the percentage of revenue generated from data has also increased substantially. Contrary to the introduction of MNP service, 3G services alleviate fierce competition among mobile operators and allow the companies to differentiate themselves by consumer type, as operators can emphasize the speed of the mobile internet or cost of internet. All three mobile operators - Turkcell, Vodafone Turkey and Avea, invested in infrastructure and new technologies and implemented new campaigns and tariffs to sustain and increase their market share.

The number of mobile subscriptions and mobile penetration rate decreased in 2009 and 2010, primarily because of MNP and the introduction of cross-network compatible tariffs, which reduced the percentage of multiple SIM card holders. Subscription growth picked up in 2011. In 2012, the penetration rate of voice services was approximately 90% - the penetration rate excluding the age group 0-9 is over 100 percent. The penetration rate is expected to reach 100% in 2017 (Economist Intelligence Unit 2013).

4. Empirical Model

In this research, we adopt a discrete-choice modeling approach to model demand for mobile services. Berry (1994) can be referred to for a detailed overview of this model. The utility of a consumer for a product depends on the (observed and unobserved) characteristics of the consumer and the product. Unobserved product characteristics such as service quality serve as the error term in the demand equation. In this setting, prices are endogenously determined by mobile operators and can be correlated with the error term.

Following Berry (1994) and Doganoglu and Grzybowski (2007), we use a standard aggregate nested logit model to model demand for mobile voice services. In our setting, consumers make a choice whether to choose the outside good, a fixed telephone, or choose one of the differentiated goods, services of mobile operator *j*, along with fixed telephone. Consumer *i*'s utility at time *t* for the outside good is u_{i0t}.The utility of consumer *i* for services of mobile operator *j* is given by

$$u_{ijt} = u_{i0t} + \delta_j - \alpha p_{jt} + \beta\, ln(n_t) + \xi_{jt} + \xi_{gt} + (1-\rho) \in ijt \qquad (1)$$

where δ_j is product-specific intercept, p_{jt} is mobile service price and n_t denotes network effect and ξ_{jt} refers to unobserved utility of operator *j*. There are two groups, g ={0,1}. g = 0 represents outside option(i.e. fixed line telephony service), and g =1 denotes buying a mobile telephone service. $\rho, 0 \leq \rho \leq 1$ denotes the degree of within-group correlation of utilities. If $\rho = 1$, consumers consider products in a group as perfect substitutes. If $\rho = 0$, the model reduces to a simple logit. ξ_{gt} takes the same value for all products in a group and $\in_{ijt}$ is an identically and independently distributed extreme value with a Gumbel (double exponential) distribution. $\xi_{gt} + (1-\rho) \in_{ijt}$ captures consumer *i*'s remaining individual-specific taste for product *j*.

Using the methodology suggested by Berry (1994) for estimating differentiated product discrete-choice demand model, using aggregate data, we invert market-share equation to find mean utility for each option and obtain the following equation

$$\ln(s_{jt}) - \ln(s_0) = \delta_j - \alpha p_{jt} + \beta \ln(n_t) + \rho \ln(\bar{s}_{jt|g=1}) + \xi_{jt} \quad (2)$$

where s_{jt} represents the share of operator j in total sales at time t,s_0 is the share of outside option, $s_0 = 1 - \sum_j s_{jt}$, and $\bar{s}_{jt|g=1}$ denotes the within group share of operator j.

Since we do not have sales data, we approximate sales levels using subscription levels and churn rates. We approximate the locked-in customers as $(1 - c_{jt})S_{jt-1}$ where c_{jt} denotes the churn rate of mobile operator j, market size as $m_t - \sum_j (1 - c_{jt})S_{jt-1}$where m_t population in time t and S_{jt-1} is the number of subscribers in t-1, the sales of operator j as $S_{jt} - (1 - c_{jt})S_{jt-1}$, and the share of operator j,s_{jt} , as

$$\left. S_{jt} - (1 - c_{jt})S_{jt-1} \right/ m_t - \sum_j (1 - c_{jt})S_{jt-1}.$$

RPM which is ARPU divided by MOU is a financial measure widely used in industry reports. We use Revenue per minute (RPM) as a price measure. Suggested by prior literature, we assume a linear form for network effects. We approximate network effects ,n_t, by lagged penetration rates, $\left. \sum_j S_{jt-1} \right/ m_{t-1}$.

5. Data

To analyze the demand for mobile services in Turkey, data for the three mobile operators - Turkcell, Vodafone Turkey and Avea – was collected over the period from January 2009 to December 2013. The quarterly data on mobile operators' subscriber counts, revenues, mobile traffic and churn rates has been published on the website of Turkey's Information and Communication Technologies Authority (BTK). We obtain 60 monthly observations by linear approximation.

Our dataset includes subscription levels (see Figure 1), the average revenue per user per month (ARPU) (see Figure 2), the average minutes of usage per month (MOU) (see Figure 3) and monthly churn rates (see Figure 4).

Our dataset has the following limitations. We only have subscription levels and churn rates but neither sales data nor operators' price indices. We approximate sales levels using subscription levels and churn rates. We use revenue per minutes per month (RPM) as a price measure (See Figure 5). We calculate RPM per month by dividing the average revenue per user per month by the average minutes of usage per month. We approximate network effects by dividing the lagged number of subscribers by the lagged population size. Definitions of key variables are presented in Table 1.

6. Estimation Results

Table 2 presents the regression results of equation 2 using ordinary least square (OLS) regression. We find that all coefficients of the model are significantly different from zero with expected signs. Specifically, higher prices decrease mobile demand while higher installed base increase mobile demand. Furthermore, ρ is estimated to be 0.966. This suggests that choices within the group are highly correlated.

We also investigate price elasticities of the firms in order to understand the dynamics of competition in the mobile market. For that purpose, we need to compute how a price change in one operator affects both own and other operators' demand. The following formula from Berry (1994) is adopted for the estimation of price elasticities.

$$E_{p_{kt}}^{s_{jt}} = \begin{Bmatrix} -\frac{\alpha}{1-\rho} p_{jt}[1 - \rho \bar{s}_{jt|g=1} - (1-\rho)s_{jt}] & if\ k = j \\ \frac{\alpha}{1-\rho} \frac{s_{kt}}{s_{jt}} p_{kt}[\rho \bar{s}_{jt} + (1-\rho)s_{jt}] & if\ k \neq j \end{Bmatrix} \quad (3)$$

The first term in the equation above formulates own price elasticity and the second term denotes cross price elasticity. The elasticities are estimated as a function of time as their values are time dependent. The coefficient estimates in the second column of Table 2 are used in the calculation of elasticities.

Figure 6 shows the percentage change in demand as a result of 1% increase in own price. We observe that own price elasticities of operators have decreased over time. Among all operators, Turkcell has the highest own price elasticity over time and faces the most decline in elasticities. The possible reason for this observation is that Turkcell was the most expensive operator and its price has decreased the most as the competition has increased over time as a result of the increase in other operators' market share, mobile number portability and introduction of 3G services. Since Turkcell has higher prices and higher margin compared to other operators, it has to decrease its prices more in order to protect its market share. Over time, the prices of operators become relatively close to each other and elasticities became similar to each other by the end of 2013. The own price elasticies of Avea are slightly higher than Vodafone initially. However, they are mostly similar during the second half of time period.

Figure 7 illustrates the change in Turkcell's demand as a result of 1% change in price of Avea and Vodafone. In general, the change in Vodafone's price affects the demand of Turkcell more than the the change in Avea's price.

Figure 8 and 9 present the change in the demand of Vodafone and Avea as a result of change in the price of other operators respectively. In both figures, the change in Vodafone and Avea's demand as a result of the change in Turkcell's price is the highest. The possible reason for this lies in the fact that Turkcell is the most expensive operator among all operators. Thus, customers are more responsive to the change in Turkcell prices. We also observe that cross price elasticities tend to decline over time. Hence, the demand of an operator become less responsive to other operators' price change as prices of firms converge to each other over time.

We estimate only price elasticities for each operator using the mean values of parameters in equation 3. In this way, we obtain average values of own and cross price estimates and these figures help us understand the big picture of the market. The coefficient estimates of the second column in Table 2 are used for α and ρ parameters. The following matrix is obtained from equation 3.

Table 3 shows the average own and cross price elasticities of operators. For example, 1% price increase by Avea leads to a decrease in its own demand by 1.99% on average. However, the demand for Turkcell and Vodafone increases by 0.63% and 0.64%, respectively, as the prices of these operators become relatively cheap compared to Avea. Similarly, a 1% price increase by Turkcell (Vodafone) results in 2.42% (1.73%) decrease of own demand on average, while the demand for Avea (Avea) and Vodafone (Turkcell) increases by 1.75% (0.80%) and 1.74% (0.78%) respectively. In general, the cross and own price elasticities of Turkcell are relatively higher than the other operators as it has a relatively higher price and higher market share. Consequently, its demand is more sensitive to change in other operators' price and own price.

7. Conclusion

In this research, we analyze the impact of network effects on the demand for Turkish mobile telecommunication services. Following Berry (1994), we use a standard aggregate nested logit model to model the demand for mobile telecommunication services. Our analysis reveals that besides prices, network effects have an impact on market growth. While service prices have a significant negative impact on the demand for mobile services, network effects have a

significant positive impact on the demand for mobile services. Our work shows that network effects impact consumers' subscription decisions to mobile telecommunication services. Omitting the network effects and attributing the changes in demand solely to changes in prices would lead to false conclusions about competition in the mobile telecommunication market in Turkey. We also plot elasticities over time. Through these graphs, it is possible to see the dynamics of competition and the effect of MNP and introduction of 3G services.

Our dataset has the following limitations. We don't have data on operators' actual sales and price indices. We approximate sales levels using subscription levels and churn rates and use RPM as a price measure. Similarly, we approximate network effects by lagged penetration rates.

Our work can be extended in several directions. A richer data set with additional variables would further enhance our understanding of the factors affecting the demand for mobile services. Specifically, we want to extend our work with the analysis of demand for mobile data services. This will enable us to explore the relationship between the demand for voice services and demand for data services to understand how subscription to voice services impacts the demand for mobile services or vice versa.

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Figure 1: Subscriber Number of Operators in Millions

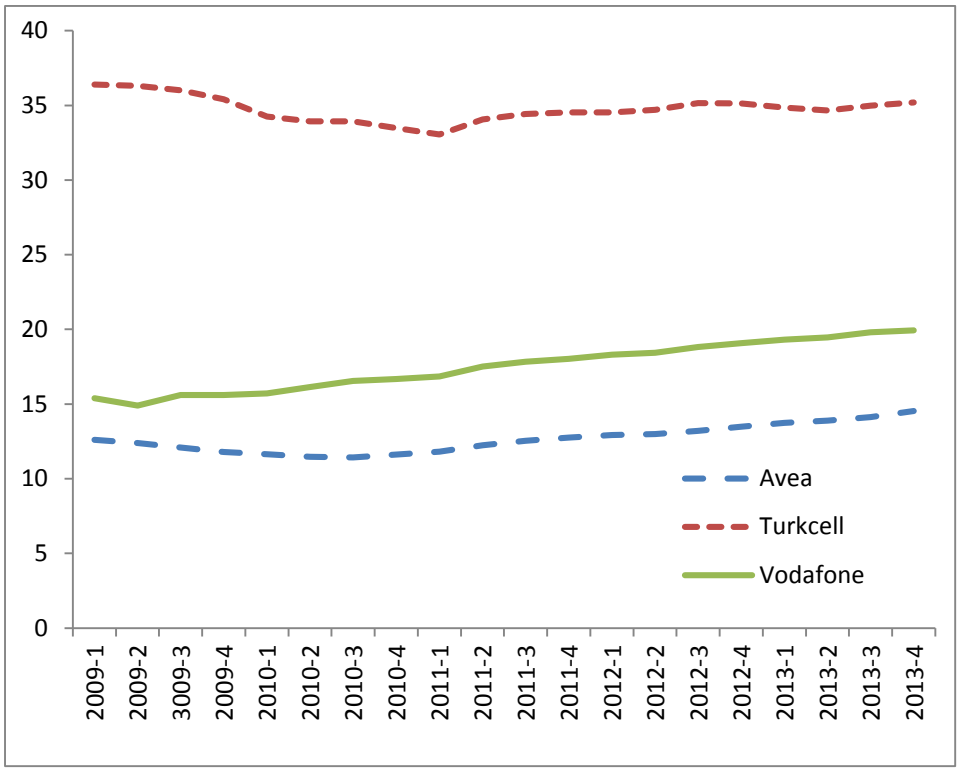

Figure 2: Average Revenue per User (ARPU) of Operator

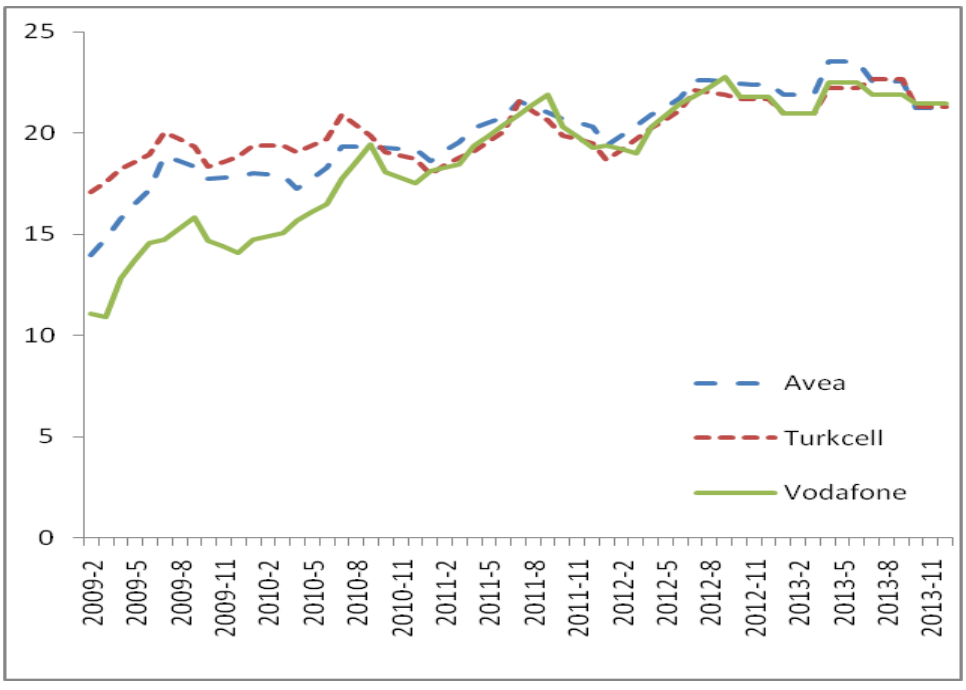

Figure 3: The Average Minutes of Voice Communication (MOU)

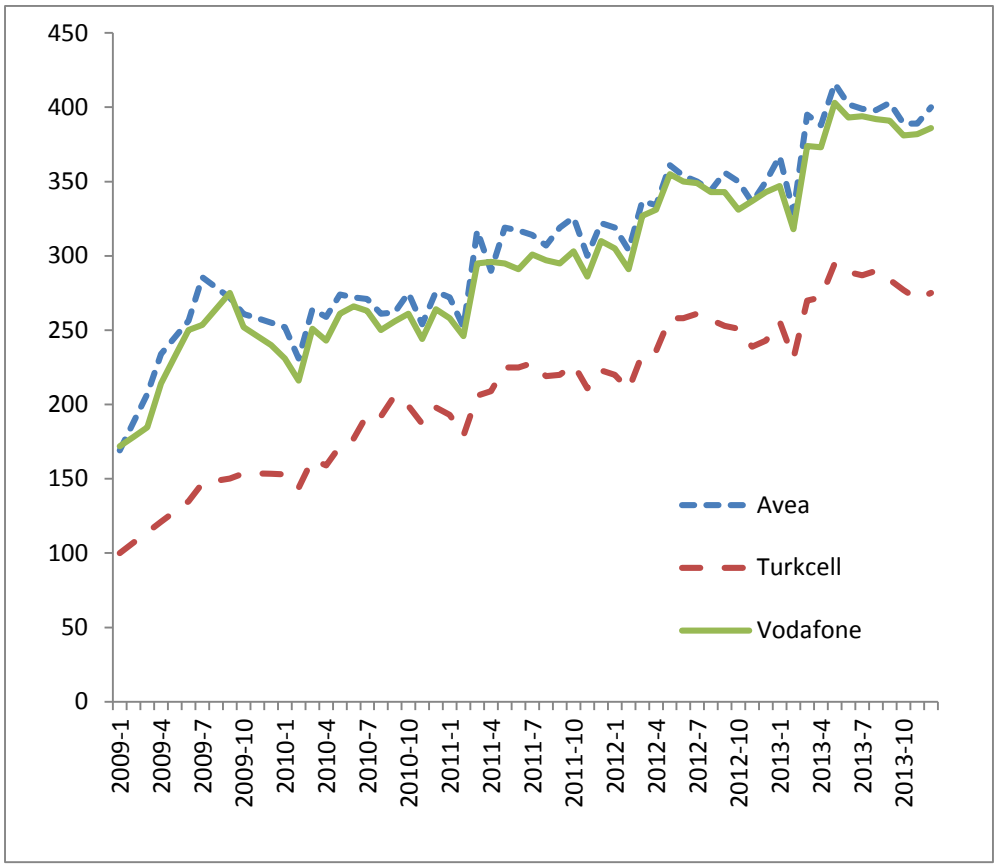

Figure 4: Churn rates of Operators

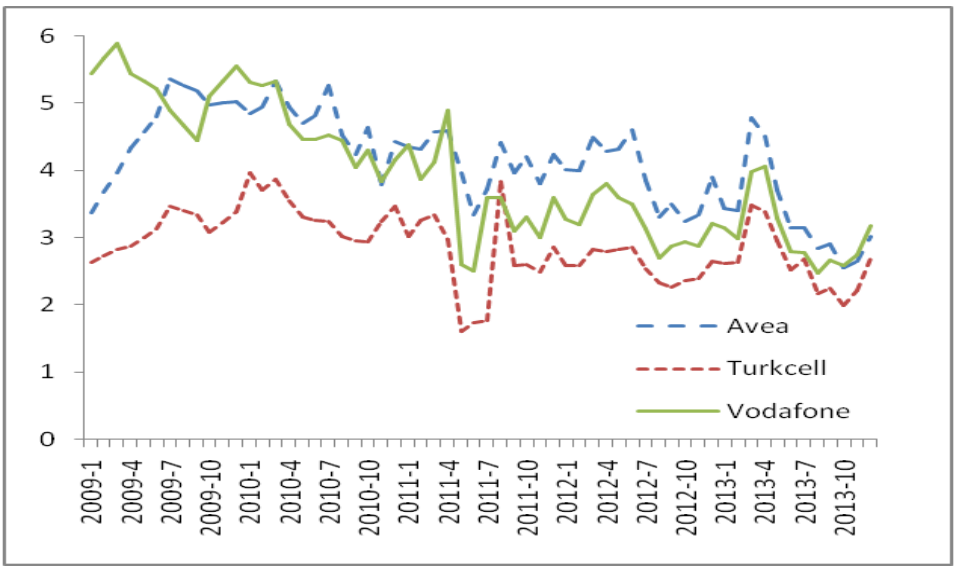

Figure 5: Average Revenue per Minute (RPM) of Operators

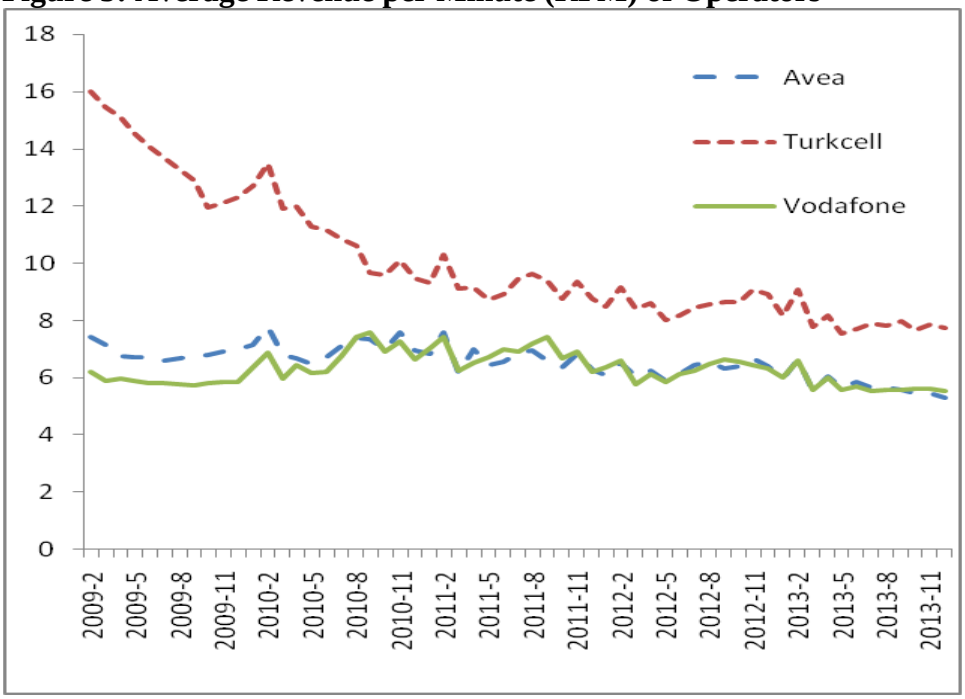

Figure 6: Own Price Elasticities of Operators

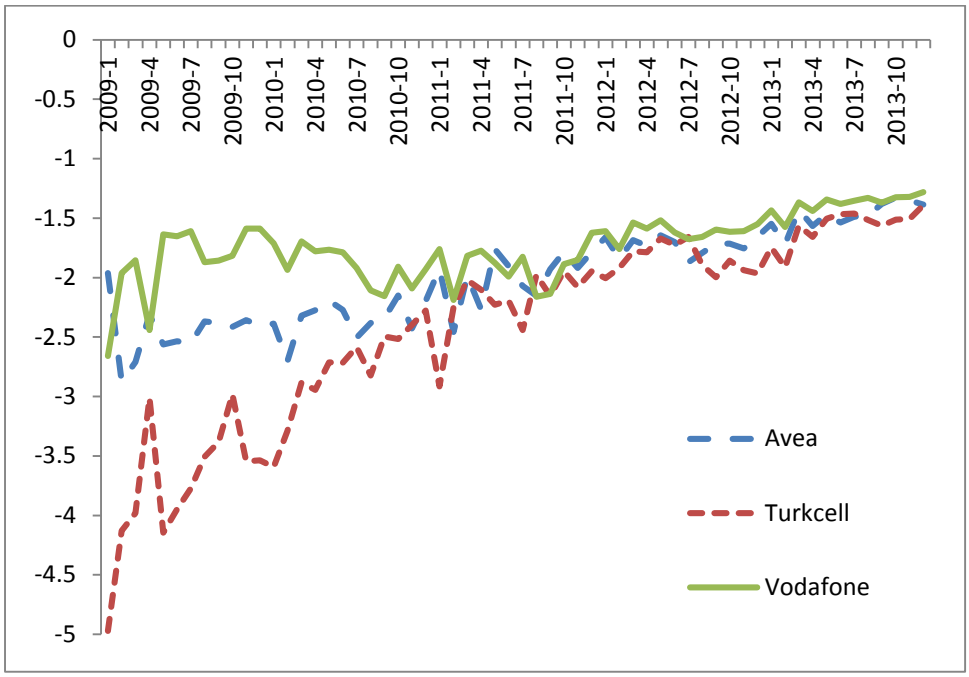

Figure 7: The Change of Turkcell's Demand As A Result of Avea and Vodafone's Price Change

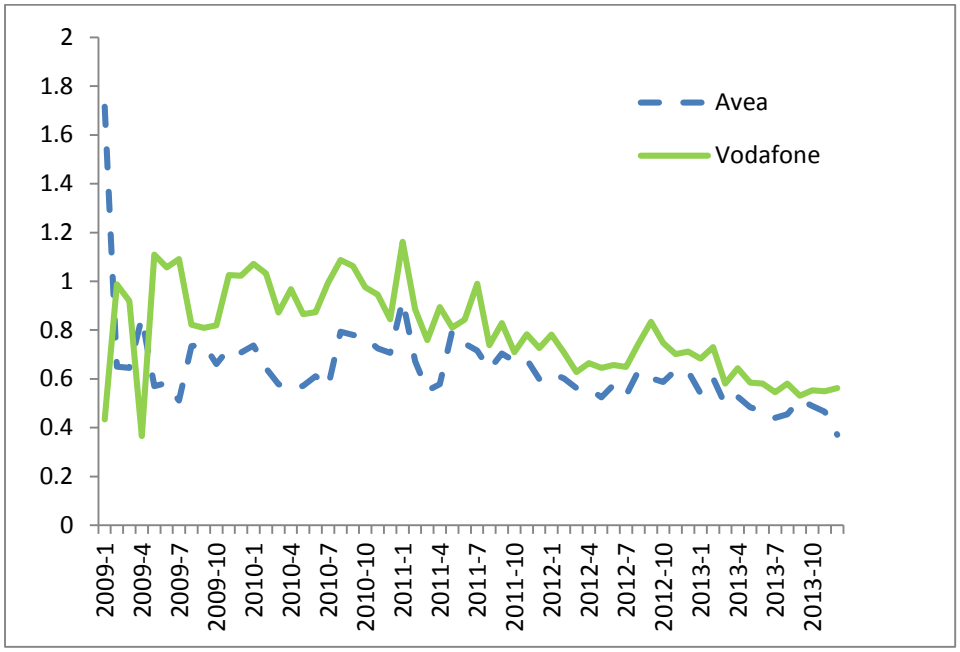

Figure 8: The Change of Vodafone's Demand As A result of Avea and Turkcell's Price Change

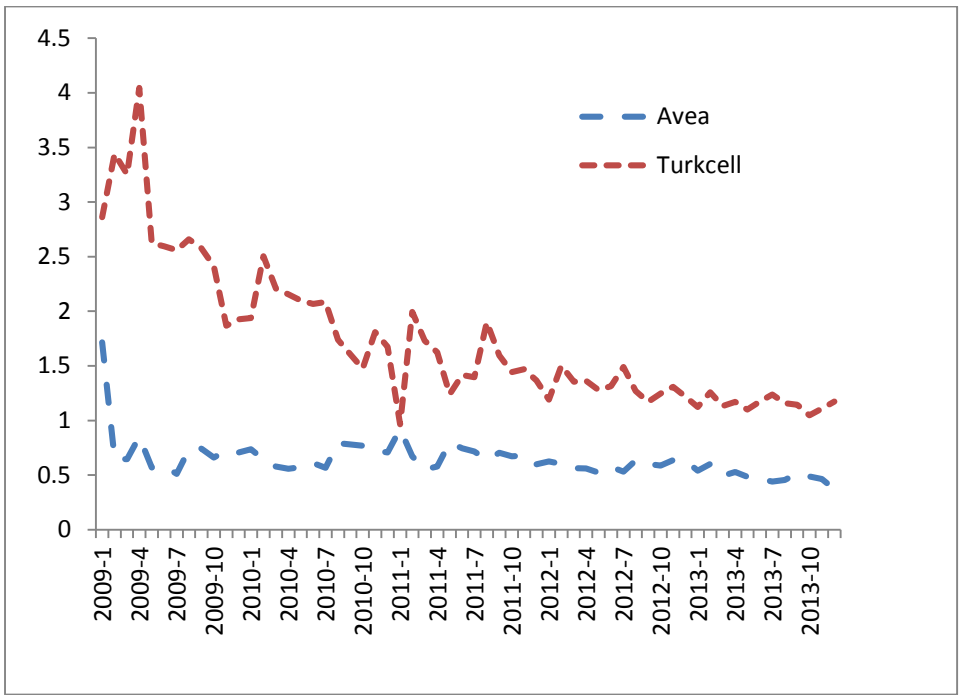

Figure 9: The Change of Avea's Demand as a result of Vodafone and Turkcell's Price Change

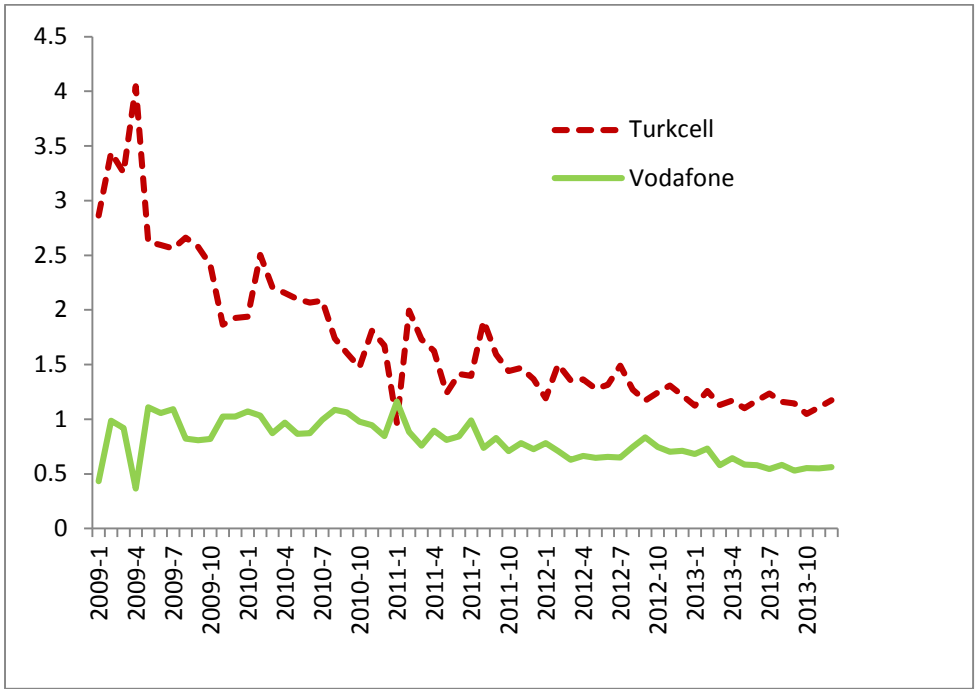

Table 1: Description of Variables

Variable	Description and measure
$\ln(s_{jt})$	the natural logarithm of the share of operator *j* in total sales at time *t*
p_{jt}	Revenue per minute (RPM) of operator *j*at time *t*
$\ln(n_t)$	the natural logarithm of lagged penetration rates
$\bar{s}_{jt\|g=1}$	the within group share of operator *j*

Table 2: The Estimate of Coefficients Using OLS

	(1)	(2)
Price per Minute	- 227.575*	- 258.245**
	(121.413)	(113.862)
ln(Network Effect)		1.236***
		(0.244)
ln(Within Market Share)	0.947***	0.966***
	(0.091)	(0.086)
Avea Dummy	-0.101	0.392***
	(0.041)	(0.088)
Turkcell Dummy	0.063	-0.792***
	(0.051)	(0.176)
Constant	-1.393	0.431
	(0.114)	(0.276)
N	180	180
R2 overall	0.669	0.7122

Standard errors are shown in paranthesis. $^{*}p< 0.1$, $^{**}p< 0.05$, $^{***}p< 0.01$

Table 3: The Average Own and Cross Price Elasticites for Operators

	Avea	Turkcell	Vodafone
Avea	-1.99	0.63	0.64
Turkcell	1.75	-2.42	1.74
Vodafone	0.80	0.78	-1.73