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Competition in the Turkish Mobile Telecommunications Market: Price Elasticities and Network Substitution[*]

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Abstract

This paper estimates demand elasticities for the Turkish mobile telecommunication market. In contrast to most other studies, firm level data is used to estimate dynamic panel data models including instrumental variable techniques. Both short- and long-run elasticities are calculated, yielding a long-run price elasticity of -0.72 for the post-paid market and of -0.33 for the pre-paid market. The short-run price elasticity is estimated to be -0.36 for the post-paid market and -0.20 for the pre-paid market. In addition, evidence of fixed to mobile traffic substitution is provided for consumers that use pre-paid cards.

Keywords: Mobile telecommunications; price elasticity; network substitution; dynamic panel data analysis

JEL C23, L13, L96

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1. Introduction

The unsatisfactory performance of Turkey's mobile telecommunications market has been documented and analysed by two recent contributions. Burnham (2007) and Atiyas and Dogan (2007) provided detailed qualitative studies of competition in the Turkish telecommunications industry and derived various policy recommendations for how to increase competition through regulatory reforms.

In order to better understand the allocative efficiency gains from regulatory reforms it is crucial to have knowledge about demand elasticities (Manfrim & da Silva, 2007; Dewenter & Haucap, 2008). This paper therefore complements the two qualitative studies mentioned above by quantitative estimates of mobile demand elasticities in Turkey. To the best of the authors' knowledge, this study is the first to conduct such a quantitative empirical analysis of the Turkish mobile telecommunications market.

Quite generally, the magnitude of mobile telecommunications demand elasticities has also been the subject of debate in various hearings on price regulation and the allocation of common costs, for which demand elasticities play an important role (e.g., for Ramsey pricing). For example, most recently estimates of mobile demand elasticities have played a significant role in the debate about the regulation of mobile termination rates in New Zealand (New Zealand Commerce Commission, 2009). Similarly, the extent of fixed-to-mobile substitution has been a key issue for regulatory authorities when delineating markets for regulatory purposes (Briglauer, Schwarz, & Zulehner, 2010).

As understanding demand elasticities has become important for a better regulation of mobile markets and the underlying cost-benefit-analyses, the number of studies that estimate demand elasticities has also been increasing, some of which are reviewed in section 2 of this paper. The present paper adds to this literature by providing estimates for demand elasticities in a highly concentrated market. In contrast to most other research the analysis presented in this paper uses firm level data for the estimates and does not have to retreat to country-level data, even though the data used covers 90% of all Turkish customers. Moreover, since dynamic panel techniques are applied, one can also distinguish between short-run and long-run demand elasticities for both pre-paid and post-paid customers.

The remainder of the paper is structured as follows: In section 2 the available empirical evidence on demand elasticities in mobile telecommunications markets is briefly reviewed

and the relationship between the approach used in this paper and the previous literature is discussed. In section 3 the competitive situation in Turkey's mobile telecommunications market is described, before the empirical analysis (including a description of the data used) is presented in section 4. Section 5 summarises the results and concludes.

2. Brief Review of Empirical Studies on Mobile Demand Elasticities

Empirical studies on demand elasticities for mobile telecommunications markets have, in principle, used two different approaches. While the first approach is based on highly aggregated data on country or regional level, a second method to measure price elasticities relies on individual or survey data of consumer behaviour. Independently of whether aggregate or individual data has been used, most studies of mobile demand elasticities have found relatively moderate price elasticities.

In one of the first empirical studies, Hausman (1999) found a price elasticity of access to mobile services of -0.51, using aggregate data on 30 U.S. markets for the period 1988 to 1993. Analysing the price elasticity of subscription using data on 64 different countries, Ahn and Lee (1999) estimated an average subscription price elasticity of -0.36. In 2003, the UK Competition Commission (2003) reported own-price elasticities of mobile subscriptions between -0.08 and -0.54, summarising the results from different studies by DotEcon, Frontier Economics and Holden Pearmain. For mobile calls, own-price elasticities between -0.48 and -0.62 were measured. In a study on the Australian mobile market, Access Economics reports a price elasticity of -0.8 (UK Competition Commission, 2003). Rodini, Ward, and Woroch (2003) analysed the fixed and mobile telecommunications access in the U.S. and, for this purpose, estimated both own and cross-price elasticities. Using survey data on telephony services, their study found own-price elasticities of -0.43 for mobile subscription rates. Furthermore, a total elasticity of -0.6 was estimated for the access and usage price.

A rather different approach to analyse conduct in mobile markets was chosen by Parker and Röller (1997) and Grzybowski (2008), who both applied structural models in order to examine the competitive behaviour of mobile operators. While Parker and Röller (1997) found an own-price elasticity of -2.5, using data on the United States covering the period from 1984 to 1988, Grzybowski (2008) found rather moderate elasticities for the EU countries between 1998 and 2002, ranging from -0.2 to -0.9. Tischler, Venture, and Walters (2001) estimated the mobile demand elasticity in Israel to be -0.8. Results in a similar range were

reported by the New Zealand Commerce Commission (2003) and by Manfrim and da Silva (2007) for a number of additional studies.

More recently, Dewenter and Haucap (2008) analysed price elasticities in the Austrian market for mobile telecommunications services, using data on firm specific tariffs over the period from January 1998 to March 2002. Their study was the first to use dynamic panel data regressions to estimate short-run and long-run demand elasticities for business customers and for private consumers with both post-paid contracts and pre-paid cards. They found that business customers have a higher long-run elasticity of demand (-0.74) than private consumers (-0.37), where post-paid customers tend to have a higher long-run demand elasticity (-0.67) than pre-paid customers (-0.20). In addition, their paper also provided estimates for firm-specific demand elasticities in the range from -0.47 to -1.1.

Another issue in the empirical analysis on telecommunications markets is the relation between fixed and mobile telecommunications, which has been one of the subjects of empirical telecommunications research more recently. The key question is whether fixed-line and mobile telecommunications services are substitutes or complements. Due to technological progress mobile network costs have decreased while the quality of mobile telecommunications services has increased so that mobile networks have started to become competitive vis-à-vis fixed-line networks. The studies that analyse fixed-mobile substitution do not have unambiguous results but rather vary with the definition of mobile demand (penetration or traffic) and the countries analysed (emerging and developed countries). For example, Gruber and Verboven (2001) find that the availability of fixed-line networks has a negative effect on the diffusion of mobile telephones in the European Union, whereas a positive correlation is found for Central and Eastern European countries by Gruber (2001). In a recent study, based on data from 1997 through 2004, Mao, Tsaib, and Chen (2008) argue that different substitution effects can be observed in different economies. While in more developed countries substitution is mainly taking the form of “traffic substitution”, a “penetration substitution” can be observed in emerging economies, due to the importance and magnitude of income effects.

The study by Rodini, Ward, and Woroch (2003) mentioned above estimates the substitutability of fixed and mobile services for telecommunications access using a household survey conducted over the period 2000–2001 in the U.S. They find that the cross-price elasticity of fixed access price on mobile demand is positive and statistically significant (0.18 for 2000 and 0.13 for 2001) and conclude that second fixed line and mobile services are

substitutes for one another. In yet another study, Madden, Coble-Neal, and Danzel (2004) analyse traffic demand and subscription separately and find that the development of fixed lines has a positive effect on the diffusion of mobile telecommunications, albeit the cross-price elasticity is positive which suggests that the two services are substitutes.

In order to analyse the demand elasticities for the Turkish mobile telecommunications market, this paper uses dynamic panel data models including instrumental variable techniques, which facilitate the calculation of short-run as well as long-run elasticities. In contrast to most other existing studies, firm level data is used for the five different mobile operators which have been active over various times in the Turkish mobile telecommunications market between January 2002 and December 2006. The data was derived from the incumbent fixed line network operator that supplies more than 90% of the fixed line traffic in Turkey. The five mobile telecommunications operators cover the entire market in Turkey, although not all of them were continuously operating during the period. While Turkcell and Telsim (today: Vodafone Türkiye) were active in the market since 1994, Aria and Aycell only entered in 2001 and merged to form a joint operator, Avea, in 2003, which then left the market in a three-player oligopoly structure.

The analysis presented firstly differs from other studies because data on firm specific tariffs is used and, secondly, because dynamic panel techniques are applied. Hence, one can distinguish between short-run and long-run demand elasticities. Furthermore, instrumental variable techniques are applied to avoid endogeneity bias. Hence, the study presented here is not only the first quantitative study of Turkey's mobile telecommunications market, but a unique and innovative feature of the study is also the joint control for unobserved heterogeneity, persistence of mobile traffic over time, and endogeneity bias based on firm-level data.

Before the empirical analysis is presented, the Turkish market for mobile telecommunications services is briefly described in the following section.

3. Overview of Turkish Telecommunication Markets

The Turkish market for mobile telecommunications has remained one of the most concentrated markets in Europe (Atiyas & Dogan, 2007). While Turkcell and Vodafone Türkiye (previously: Telsim) have offered GSM mobile telephone services since 1994, further market

entry did not occur until 2001 when Aria (a consortium of Italian TIM and Turkish ISBANK) and Aycell (a Turk Telekom affiliate) entered the market.

During the duopoly period from 1994 to 2001, Turkcell managed to keep the majority of the market. This is at least partly due to the fact that the operations of Telsim were suspended between November 1995 and June 1996 due to a managerial fraud concerning a profit sharing agreement with the Turkish Treasury. The incidents let suspicions grow about the financial viability of Telsim's services so that Turkcell managed to regain significant market shares between 1995 and 1996. While Telsim had regained a market share of 31.5% in 1998, it lost market share again after two additional firms, namely Aria and Aycell, entered the market after a controversial government auction[1] of additional spectrum licenses in 2001.

Table 1. Market Shares of Mobile Telecommunication Networks in Turkey

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

Source: Telecommunications Authority of Turkey

The two entrants faced a rather difficult economic environment, as a result of a severe financial crisis in Turkey which led to a 10% decrease in GDP and an according decrease of total demand. In addition, the two entrants also entered a rather hostile regulatory terrain. As Atiyas and Dogan (2007) convincingly argued the Turkish telecommunications regulator failed to facilitate effective competition, as it did not manage to implement effective roaming

[1] This auction was described as a "fiasco" by Binmore and Klemperer (2002, p. 93) because "the Turkish government auctioned two licenses sequentially, but set the reserve price for the second license equal to the price at which the first license was sold. One company then bid much more for the first license than the market thought it could be worth if the company had to compete with a rival holding the second license. But the company had rightly figured that no rival would be willing to bid that high for the second license, which therefore remained unsold, leaving the company without a rival operating the second license." Subsequently, the Turkish government made arrangements for a new sale of the unsold license. Also see Atiyas and Dogan (2007, p. 506) for a similar view.

and interconnection policies, even though both the government and the regulator favoured the new entrants. In a nutshell, the roaming obligations that were imposed on incumbents proved ineffective as the incumbents used legal tactics to significantly delay the implementation process. And the interconnection rates were set by the incumbents at a rather high level which the entrants did not challenge. This alone may have been harmless if the high termination rates had not been paired with significant off-net/on-net price differences that were used to discipline entrants, as also described extensively by Atiyas and Dogan (2007).

As in many other emerging economies, the significant price differences between on-net and off-net prices have led many consumers to hold multiple SIM cards of different operators. In fact, the incidence of multiple SIM ownership has been common in many emerging markets for quite some time due to the large difference between on-net and off-net tariffs.[2] For a third and fourth entrant, however, it has proved difficult to enter the market and to gain significant market shares under these circumstances (see Table 1). It may be interesting to report, though, that Vodafone Turkey's General Manager, Serpil Timuray, has recently stated in an interview that the percentage of multiple SIM card holders has now declined to some 20% (June 2009), while it was still at 29% in November 2008, and even higher before.[3] According to market participants, the main reason for multiple SIM card utilisation now to decline is the recent introduction of new cross-network compatible tariffs served by operators. Multiple SIM users now apparently tend to discard extra cards in favour of one operator now.[4]

The third crucial barrier to entry and to growth for new entrants has been the lack of mobile number portability, inducing significant switching costs for consumers when leaving an incumbent for a new entrant (Buehler & Haucap, 2004). It may be noted though that this situation is now remedied for mobile number portability was implemented in 2008.

Given the lack of mobile number portability and ineffective roaming and interconnection policies, paired with significant differences between on-net and off-net prices, the two entrants did not manage to make a major inroad into the Turkish mobile telecommunications markets during their first two years. Therefore, the two firms decided to merge in 2003 to form a new entity called Avea (also see Table 1).

The aim of this paper is not to replicate the thorough analysis of Atiyas and Dogan (2007), who have examined the lack of competition and its reasons in the Turkish market for mobile

[2] See http://www.telecomspricing.co.uk/news_detail.cfm?item=18
[3] See http://www.turk.internet.com/portal/yazigoster.php?yaziid=25113
[4] See http://www.reuters.com/article/idUSL559514420090805

telecommunications services. The present paper rather wants to complement that analysis now with econometric evidence about the Turkish mobile telecommunications market.

4. Empirical Analysis

4.1. Data and Model Specification

In order to analyze the demand structure of Turkish mobile telecommunications markets, monthly data for the five different firms mentioned above is used over the period from January 2002 to December 2006. The data on mobile traffic, prices, and networks' subscriber bases has been provided by the Turkish Telecommunications Authority (TA). Definitions of the relevant variables and descriptive statistics can be found in Tables A1-A4 in the appendix.

The quantity variable (mobile traffic), as the starting point for estimating demand equations and calculating price elasticities, is out-going off-net traffic per subscriber of the respective mobile networks. The reason for not including on-net traffic into the empirical analysis is that competitive forces in Turkey drove network operators to subsidize on-net calls to an extent that on-net calls were effectively free of charge. As information on the detailed traffic structure for on-net calls was not available, the quantities for which consumers were not charged, have not been used in the analysis. While mobile markets are characterized by price differentiation among different consumer groups, standard tariffs that discriminate only between on-net and off-net calls are used, as more detailed data has not been available.

In order to estimate own price elasticities and cross price elasticities regarding fixed line tariffs, regressions are first conducted for the aggregate market. In addition, separate estimates are provided for different segments of the Turkish mobile telecommunications market in a second regression analysis. The intuition underlying this disaggregation is that different market segments, namely pre-paid and post-paid customers, are usually characterized by different demand characteristics. In the analysis presented in this paper, the variable "total number of outgoing off-net minutes" measures the monthly off-net traffic (Q) for pre-paid and post-paid customers. Furthermore, in order to cover the demand growth that results from network effects and the construction and extension of new networks, the average outgoing off-net minutes per subscriber (q) are constructed for each network within a given market. The off-net tariff for fixed line networks has been used as explanatory variables along with population and GDP per capita. In addition, a linear time trend has been included to capture

the effect of technological progress. All price variables have been deflated by the Turkish consumer price index to obtain real prices.

A standard approach for the estimation of demand elasticities in telecommunications is derived from the so-called Houthakker-Taylor model, which takes possible path dependencies of consumption into account (Houthakker & Taylor, 1970). For these reasons long-run elasticities are expected to differ from short-run elasticities, as consumers may only react with some time lag. If consumers' calling behaviour is shaped by habits and routines, demand is expected to be more elastic in the long-run when consumers change their consumption patterns. According to the Houthakker-Taylor model, demand q at time t can be expressed as

$$q_t = q_{t-1}^{\beta} p_t^{\gamma},$$

or, taking logarithms of both sides, as

$$\ln q_{it} = \alpha_i + \beta \ln q_{it-1} + \sum_j \gamma_j \ln p_{jt} + \sum_k \delta_k \ln x_{it,k} + \varepsilon_{it}.,$$

where q_{it} is the average quantity demanded for tariff i at time t, p_{jt} is the respective average price for the firm under consideration ($j = i$). Furthermore, $x_{it,k}$'s are k additional explanatory variables, ε_{it} is an error term, and β, the γ_j's and the δ_k's are the parameters to be estimated.

4.2. Model Identification and Results

In order to estimate dynamic panel data models the Arellano-Bond-Estimator is used, due to endogeneity problems with respect to the lagged dependent variable and prices. Following Arellano and Bond (1991), the second lag of traffic per capita is used as an instrument for the lagged dependent variable. In addition, wages are used as instruments and several cost shifters are included in the set of instrumental variables. These instruments include the real interest rate, the telecommunications equipment price index, the number of base stations, and the price index for services in Turkey. These cost shifters are used as instruments because they have a direct effect on endogenous price variables, but not a direct effect on telecommunications traffic[5]. In the following, results are first presented for the aggregate Turkish mobile telecommunications market, before separate estimations for pre-paid and post-paid customers are discussed.

[5] See Kaiser and Wright (2006) for further discussion of this kind of instrumental variables.

Table 2. Estimation Results for the Entire Market

Outgoing traffic per capita	Coeff.	Std. Err.
Outgoing traffic per capita$_{-1}$	0.701***	0.075
Mobile off-net tariff	-0.277***	0.074
Fixed-line off-net tariff	0.256***	0.099
Population	73.810	184.358
GDP per capita	0.157**	0.078
Time	-0.092	0.233
Obs.	332	-
R^2	0.62	-
Hansen J statistic	6.637	Prob. 0.249
Weak identification test[#]	16.352	Less than 5% maximal IV relative bias

***, **, * statistically significant on the 1, 5, and 10% level, [#] maximal relative IV bias obtained from critical values in Stock and Yogo (2005), standard errors are heteroskedasticity robust.

Table 2 presents the regression results for the aggregate Turkish mobile telecommunications market. The Hansen J statistic indicates that the regression does not suffer from over-identification problems. Furthermore, the weak identification test (Kleibergen & Paap, 2006) shows that the maximal relative IV bias is less than 5%.[6] Weak identification tests based on Stock and Yogo (2005) are applied because standard rules of thumb following Bound, Jaeger, and Baker (1995) only work in the case of one endogenous variable, while they are not appropriate in the case of several endogenous explanatory variables. All coefficients have the expected signs. The cross price elasticity of mobile telecommunications traffic with regard to fixed-line call prices is positive, whereas the own price elasticity of mobile traffic is negative with a value of -0.28, which is in line with the previous studies reported in section 2.

Table 3 and 4 present separate results for pre-paid and post-paid mobile telecommunications markets. One should expect that the demand functions for different market segments are

[6] The weak identification test is based on critical values obtained from Stock and Yogo (2005) and the generalized reduced rank test from Kleibergen and Paap (2006).

largely independent from each other, even though the cost shocks may affect the markets similarly. In contrast to most countries in Western Europe, the number of pre-paid consumers in Turkey is growing faster than the number of post-paid customers, where pre-paid consumers are covering 80% of the market. Furthermore, high interconnection rates, which induce major differences between on-net and off-net calling prices, are likely to be an important factor. As reported in section 3, a significant number of consumers multi-homes in order to benefit from discounted on-net calling rates. Under the assumption that a large share of post-paid subscribers are business customers, it is reasonable to assume that multi-homers are mostly pre-paid consumers who are attracted by special marketing strategies that focus on discounts for on-net communication.

Table 3. Estimation Results for the Pre-paid Market

Outgoing traffic per capita	Coeff.	Std. Err.
Outgoing traffic per capita$_{-1}$	0.727***	0.080
Mobile off-net tariff	-0.356***	0.082
Fixed-line off-net tariff	0.331**	0.146
Population	-177.119	260.985
GDP per capita	0.273***	0.081
Time	0.225	0.331
Obs.	164	-
R^2	0.80	-
Hansen J statistic	9.923	Prob. 0.128
Weak identification test[#]	11.060	Less than 10% maximal IV relative bias

***, **, * statistically significant on the 1, 5, and 10% level, [#] maximal relative IV bias obtained from critical values in Stock and Yogo (2005), standard errors are heteroskedasticity robust.

Table 3 presents the estimation results for the pre-paid market. The own price elasticity is considerably lower than the aggregate market elasticity reported in Table 2. This result also holds for the cross-price elasticity of fixed line services which is significant at the 5%-level

and has a value of 0.33. That suggests that fixed-line telephony and mobile telephony are substitutes for pre-paid customers.

The diagnostic checks exhibit similar results as for the estimation of the aggregate market demand. This suggests that the overall fit is reasonably good and the IV bias is less than 10% compared to OLS estimations. The null hypothesis of over-identification is also rejected.

Table 4. Estimation Results for the Post-paid Market

Outgoing traffic per capita	Coeff.	Std. Err.
Outgoing traffic per capita$_{-1}$	0.658***	0.192
Mobile off-net tariff	-0.202*	0.117
Fixed-line off-net tariff	0.169	0.123
Population	357.329	315.094
GDP per capita	0.057	0.164
Time	-0.451	0.398
Obs.	165	-
R^2	0.25	-
Hansen J statistic	7.162	Prob. 0.306
Weak identification test[#]	4.621	Less than 30% maximal IV relative bias

***, **, * statistically significant on the 1, 5, and 10% level, [#] maximal relative IV bias obtained from critical values in Stock and Yogo (2005), standard errors are heteroskedasticity robust.

Table 4 presents the estimation results for the post-paid market. As in the previous estimations, all coefficients have the expected signs but the effects are significantly weaker. One also has to mention that the IV bias is considerably larger than in the regressions for the whole and the pre-paid market, but it is still acceptable low. The own price elasticity in the post-paid market is smaller as its counterpart in the pre-paid market and as a consequence, even smaller as in the whole market. One reason for this observation may be that there are most likely more business customers on post-paid contracts. Under the (reasonable) assumption that business customers are mainly post-paid customers the price elasticity of demand may be smaller compared to other consumers for at least three reasons. Firstly,

business customers may find it more difficult to avoid or to postpone business calls than private customers. Secondly, employees using their business mobile phone may care less about the actual price than private consumers, as the company may be paying their phone expenditures. And thirdly, business customers may be less likely to multi-home (i.e., to hold multiple SIM cards of alternative operators) if they enter into exclusive contracts with one particular operator. In this case, they cannot use an alternative SIM card to place an on-net call instead of an off-net call, i.e. it is more difficult to avoid off-net calls for business customers so that their demand elasticity for off-net calls should be lower. Finally, pre-paid consumers (which may be assumed to include students and younger people) may be more price-sensitive because they may have a lower income.

Also note that, in contrast to pre-paid customers, the cross-price elasticity is not significant for post-paid customers (even though it has a positive sign). This suggests that fixed-line and mobile telecommunications services are more difficult to substitute for post-paid customers. Assuming again that business customers are rather on post-paid than on pre-paid tariffs, it is understandable that fixed-line and mobile calls are more difficult to substitute as calls may be more difficult to postpone and both services may be needed.

The Houthakker-Taylor model also allows for a distinction between short-run and long-run elasticities. Note from the Houthakker-Taylor model that current demand can be expressed as $q_t = q_{t-1}^{\beta} p_t^{\gamma}$. The short-run price elasticity is determined by γ, whereas the long-run price elasticity equals $\gamma/(1-\beta)$. Table 5 compares short-run and long-run elasticities for both the aggregate market and for pre-paid and post-paid markets separately.

Table 5: Short-Run and Long-Run Elasticities

	Entire Market	Prepaid Market	Postpaid Market
Short-run elasticity	-0.28	-0.36	-0.20
Long-run elasticity	-0.45	-0.33	-0.72

As may be expected, short-run elasticities are smaller in the post-paid market. This observation is quite intuitive, as post-paid customers usually have contracts lasting over a given period of time (e.g., two years). Hence, it may take some time to change one's behaviour as one may have to change its contracts which takes some time. In contrast, pre-paid customers are usually quite flexible to switch between mobile telecommunications

providers in the short-run, especially if they multi-home by holding multiple SIM cards. Hence, it is not surprising that there is no significant difference between the short-run and the long-run elasticity for pre-paid customers.

It may also be interesting to note at this point that, in their study of the Austrian mobile telecommunications market, Dewenter and Haucap (2008) found that Austrian business customers have a higher long-run elasticity of demand (-0.74) than private consumers (-0.37) and that post-paid customers tend to have a higher long-run demand elasticity (-0.67) than pre-paid customers (-0.20). These results are astonishingly similar to the results for Turkey presented in this paper.

5. Conclusion

This paper has analyzed the demand for mobile telecommunications services in Turkey. Dynamic panel data techniques have been applied in order to estimate short- and long-run price elasticities, as well as fixed network substitution. The study presented here is the first econometric analysis of the growing mobile telecommunications sector in Turkey, using firm level data of five competitors, covering two market segments (pre-paid and post-paid) between January 2002 and December 2006.

The results suggest that pre-paid consumers have a more elastic demand than post-paid consumers. One of the reasons may possibly be that institutional and business groups are more likely to be on post-paid contracts. These customers may find it more difficult to avoid or to postpone business calls than private customers. Moreover, employees using their business mobile phone may care less about the actual price than private consumers, as the company may be paying their phone bill. In addition, business customers may be less likely to multi-home (i.e., to hold multiple SIM cards of alternative operators) if they enter into exclusive contracts with one particular operator. In this case, they cannot use an alternative SIM card to place an on-net call instead of an off-net call, i.e. it is more difficult to avoid off-net calls for business customers so that their demand elasticity for off-net calls should be lower. And finally, pre-paid consumers (which may be assumed to include students and younger people) may be more price-sensitive because they may have a lower income.

In contrast to pre-paid customers, the cross-price elasticity between fixed-line prices and mobile traffic is not significant for post-paid customers. This suggests that fixed-line and mobile telecommunications services are more difficult to substitute for post-paid customers

than for pre-paid customers. Assuming again that business customers are rather on post-paid than on pre-paid tariffs, it is understandable that fixed-line and mobile calls are more difficult to substitute for these consumer groups as calls may be more difficult to postpone and both services may be needed for them.

As may be expected, short-run elasticities are smaller in the post-paid market. This observation is quite intuitive because post-paid customers usually have contracts lasting over a given period of time (e.g., two years). Hence, it may take some time to change one's behaviour as one may have to change its contracts which takes some time. In contrast, pre-paid customers are usually also quite flexible to switch between mobile telecommunications providers in the short-run, especially if the multi-home by holding multiple SIM cards. Hence, it is not surprising that there is no significant difference between the short-run and the long-run elasticity for pre-paid customers.

References

Ahn, H., & Lee, M. H. (1999). An econometric analysis of the demand for access to mobile telephone networks. *Information Economics and Policy, 11*, 297-305.

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and application to employment equations. *Review of Economic Studies*, *58*, 277-298.

Atiyas, I., & Dogan, P. (2007). When good intentions are not enough: Sequential entry and competition in the Turkish mobile industry. *Telecommunications Policy*, *31*, 502-523.

Binmore, K., & Klemperer, P. (2002). The biggest auction ever: The sale of the British 3G telecom licenses. *The Economic Journal*, *112*, C74-C96.

Bound, J., Jaeger, D. A., & Baker, R. M. (1995). Problems with instrumental variable estimation when the correlation between the instruments and the endogenous explanatory variables is weak. *Journal of the American Statistical Association, 90*, 443-450.

Briglauer, W., Schwarz, A., & C. Zulehner (2010): Is fixed-to-mobile substitution strong enough to deregulate fixed voice telephony? Evidence from the Austrian markets. Forthcoming in *Journal of Regulatory Economics*.

Buehler, S., & Haucap, J. (2004). Mobile number portability. *Journal of Industry, Competition and Trade*, *3*, 223-238.

Burnham, J. B. (2007). Telecommunications policy in Turkey: Dismantling barriers to growth. *Telecommunications Policy, 31*, 197-208.

Dewenter, R. & Haucap, J. (2008). Demand elasticities for mobile telecommunications in Austria. *Jahrbücher für Nationalökonomie und Statistik, 228*, 49-63.

Gruber, H. (2001). Competition and innovation: The diffusion of mobile telecommunications in central and eastern Europe. *Information Economics and Policy, 13*, 19-34.

Gruber, H. & Verboven, F. (2001). The diffusion of mobile telecommunication services in the European Union. *European Economic Review, 45*, 577–588.

Grzybowski, L. (2008). The competitiveness of mobile telephony across the European Union. *International Journal of the Economics of Business, 15*, 99-115.

Hausman, J. A. (1999). Cellular telephone, new products, and the CPI. *Journal of Business and Economic Statistics, 17*, 288-194.

Houthakker, H. S., & Taylor, L. S. (1970). *Consumer demand in the United States* (2nd edition). Cambridge, MA: Harvard University Press.

Kaiser, U., & Wright, J. (2006). Price structures in two-sided markets: Evidence from the magazine industry. *International Journal of Industrial Organization, 24*, 1-28.

Kleibergen, F., & Paap, R. (2006). Generalized reduced rank tests using the singular value decomposition. *Journal of Econometrics*, *133*, 97-126.

Madden, G., Coble-Neal G., & Dalzell, B. (2004). A dynamic model of mobile telephony subscription incorporating a network effect. *Telecommunications Policy*, *28*, 133–144.

Manfrim, G., & da Silva, S. (2007). Estimating demand elasticities of fixed telephony in Brazil. *Economics Bulletin*, *12*, 1-9.

Mao, C. K, Tsai, H. C., & C.M Chen (2008). FMS patterns: Penetration vs. traffic substitution in different groups of countries. *Technological Forecasting and Social Change, 75*, 356-384.

New Zealand Commerce Commission (2003). *Review of price elasticities of demand for fixed line and mobile telecommunications*. Wellington: New Zealand Commerce Commission.

New Zealand Commerce Commission (2009). *Draft report on whether the mobile termination access services (incorporating mobile-to-mobile voice termination, fixed-to-mobile voice termination and short-messages-service termination) should become designated or specified services*. Wellington: New Zealand Commerce Commission.

Parker, P. M., & Röller, L.-H. (1997). Collusive conduct in duopolies: Multimarket contact and cross-ownership in the mobile telephone industry. *RAND Journal of Economics, 28*, 304-322.

Rodini, M., Ward, M. R., & Woroch, G. A. (2003). Going mobile: Substitutability between fixed and mobile access. *Telecommunications Policy, 27*, 457-476.

Stock, J. H., & Yogo, M. (2005). Testing for weak instruments in linear IV regression. In: Andrews, D. W. K., & Stock, J. H. (eds.): *Identification and inference for econometric models*. Cambridge: Cambridge University Press: Cambridge, 80-108.

Tischler A., Ventura, R., & Walters, J. (2001). Cellular telephones in the Israeli market: The demand, the choice of provider and potential revenues, *Applied Economics, 33*, 1479-1492.

UK Competition Commission (2003): *Vodafone, O2, Orange and T-Mobile: Reports on references under section 13 of the Telecommunications Act 1984 on the charges made by Vodafone, O2, Orange and T-Mobile for terminating calls from fixed and mobile networks*, London, February 2003.

Appendix

Table A1: Description of Variables in the Dataset for the Aggregate Market

Variable	Description
Logarithm of outgoing traffic per capita	Logarithm of average outgoing traffic per capita on provider base for the whole mobile telecommunications market.
Logarithm mobile off-net tariff	Logarithm of tariff for mobile off-net calls in the whole telecommunications market on providers base.
Logarithm fixed-line tariff	Logarithm of average fixed line tariff of Turk Telecom.
Logarithm real interest rate	Logarithm of the real interest rate in Turkey.
Logarithm price index for services	Logarithm of the Turkish service price index.
Logarithm telecommunications equipment price index	Logarithm of the Turkish telecommunications equipment price index.
Logarithm wage index	Logarithm of the wage index in Turkey.
Dummy variable for holidays (June. July, and August)	Dummy variable signalling the summer months during which most countries usually have summer holidays.
Logarithm number of base stations	Logarithm of the number of base stations in Turkey.
Logarithm Turkish population	Logarithm of the Turkish population.
Logarithm GDP per capita	Logarithm of GDP per capita in Turkey.

Table A2: Descriptive Statistics for the Aggregate Market Dataset

Variable	Observations	Mean	Min	Max
Logarithm of outgoing traffic per capita mobile	356	2.50	0.76	4.51
Logarithm mobile off-net tariff	412	4.76	3.37	5.42
Logarithm fixed-line tariff	600	4.84	4.26	5.13
Logarithm real interest rate	600	3.34	2.76	4.10
Logarithm price index for services	600	4.54	4.23	4.64
Logarithm telecommunications equipment price index	600	4.44	4.15	4.64
Logarithm wage index	600	7.15	6.70	7.46
Dummy variable for holidays (June. July, and August)	600	0.25	0	1
Logarithm Turkish population	600	18.08	18.04	18.12
Logarithm GDP per capita	600	5.06	4.66	5.39

Table A3: Description of Variables in the Pre-paid/Post-paid Market Dataset

Variable	Description
Logarithm of outgoing traffic per capita pre-paid	Logarithm of average outgoing traffic per capita on provider base for the pre-paid market.
Logarithm of outgoing traffic post-paid	Logarithm of average outgoing traffic per capita on provider base for the post-paid market.
Logarithm mobile off-net tariff pre-paid	Logarithm of tariff for mobile off-net calls in the pre-paid market.
Logarithm mobile off-net tariff post-paid	Logarithm of tariff for mobile off-net calls in the post-paid market.
Logarithm fixed-line tariff	Logarithm of average fixed line tariff of Turk Telecom.
Logarithm real interest rate	Logarithm of the real interest rate in Turkey.
Logarithm price index for services	Logarithm of the Turkish service price index.
Logarithm telecommunications equipment price index	Logarithm of the Turkish telecommunications equipment price index.
Logarithm wage index	Logarithm of the wage index in Turkey.
Dummy variable for holidays (June. July, and August)	Dummy variable signalling the summer months during which most countries usually have summer holidays.
Logarithm number of base stations	Logarithm of the number of base stations in Turkey.
Logarithm Turkish population	Logarithm of the Turkish Population.
Logarithm GDP per capita	Logarithm of GDP per capita in Turkey.

Table A4: Descriptive Statistics for the Pre-paid/Post-paid Market Dataset

Variable	Observations	Mean	Min	Max
Logarithm of outgoing traffic per capita pre-paid	178	1.67	0.76	3.00
Logarithm of outgoing traffic post-paid	178	3.33	1.40	4.51
Logarithm mobile off-net tariff pre-paid	206	4.93	3.37	5.42
Logarithm mobile off-net tariff post-paid	206	4.59	3.37	5.29
Logarithm fixed-line tariff	300	4.84	4.26	5.13
Logarithm real interest rate	300	3.39	2.76	4.10
Logarithm price index for services	300	4.54	4.23	4.64
Logarithm telecommunications equipment price index	300	4.44	4.15	4.64
Logarithm wage index	300	7.15	6.70	7.46
Dummy variable for holidays (June. July, and August)	300	0.25	0	1
Logarithm number of base stations	204	8.45	6.75	9.36
Logarithm Turkish population	300	18.08	18.05	18.12
Logarithm GDP per capita	300	5.06	4.66	5.39

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