Two Sided Markets: The Case of The Waterbed Effect in OECD Mobile Telecommunications Markets

İki Taraflı Piyasalar: OECD Mobil Telekomünikasyon Piyasaları'nda Su Yatağı Etkisi Örneği

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ÖZ

En doğru analizler yapılarak uygun politikalar ve isabetli stratejiler geliştirme çabaları tek yanlı piyasalardan önemli ölçüde farklılaşan iki yanlı piyasaların incelenmesini ön plana çıkarmaktadır. Bu çalışmada iki yanlı piyasa analizleri içinde özel bir yere sahip olan mobil telekomünikasyon piyasaları ele alınmaktadır. Mobil telekomünikasyon piyasalarında arabağlantı hizmeti karşılığında alınan mobil arabağlantı ücretlerinde yapılacak merkezi bir indirimin "su yatağı etkisi" göstererek son kullanıcının piyasada karşı karşıya olduğu mobil iletişim fiyatlarının yükselmesine neden olabileceği öne sürülmektedir.. Bu kapsamda 21 OECD ülkesine ait 2005-2015 yılları arasındaki 41 çeyrek dönemlik veriler kullanılarak Ortak İlişkili Etkiler Ortalama Grup (CCEMG) yöntemi ile ampirik analiz yapılmış ve mobil iletişim fiyatının belirlenmesinde mobil arabağlantı ücretleri, gelir ve miktarın etkisi tahmin edilmiştir. Sonuçlara göre ilgili ülke gurubu için analiz edilen dönemde mobil telekomünikasyon piyasalarında su yatağı etkisi tespit edilememiş ve mobil arabağlantı ücretlerinin bir maliyet unsuru olarak hareket ederek fiyatları aynı yönlü olarak değiştirdiği ortaya konmuştur. Gelir değişkeninin katsayısı pozitif çıkmış ve gelirdeki artışın fiyatı artıracağı beklentisi karşılanmıştır. Miktarı temsil eden abone sayısı ve penetrasyon oranı açıklayıcı değişkenlerinin katsayıları negatif çıkmış ve iktisadi beklentilere ve iki yanlı piyasa özelliklerine uygun davranış gösterdikleri değerlendirilmiştir.

ANAHTAR KELİMELER

İki Taraflı Piyasalar, Mobil Telekomünikasyon Piyasası, Su Yatağı Etkisi, Arabağlantı Ücretleri, Ortak İlişkili Etkiler Ortalama Gurup Tahmincisi

ABSTRACT

Efforts to develop appropriate policies and accurate strategies through the most accurate analyzes highlight the examination of two-sided markets, which differ significantly from one-sided markets. In this study, mobile telecommunications market which has a special place in two-sided market analysis will be studied. In mobile telecommunications market, it is suggested that a reduction in mobile interconnection rates for the interconnection service will show the waterbed effect, resulting in an increase in mobile communication prices that the end user faces in the market. In this context, an empirical analysis was made by Common Correlated Effects Mean Group (CCEMG) estimator using the 41 quarter period data of 21 OECD countries between 2005 and 2015, and the effect of mobile interconnection rates, income and quantity were estimated in determining the mobile communication prices. According to the results, the waterbed effect in mobile telecommunications markets could not be determined in the period analyzed for the related country group and mobile interconnection rates acted as a cost factor and changed the prices in the same direction. The coefficient of income variable was positive and the expectation that the increase in income would increase the price was met. The explanatory variable coefficients of the number of subscribers and the penetration rate representing the quantity were negative and they were evaluated to behave in accordance with economic expectations and two-sided market characteristics.

KEYWORDS

Two-Sided Markets, Mobile Telecommunications Market, Waterbed Effect, Interconnection Rates, Common Correlated Effects Mean Group Estimator

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INTRODUCTION

Two-sided markets, which simultaneously respond to the demands of more than one group of consumers with different demands simultaneously on time with the needs and innovations brought by time, have become an important part of social life and economy. Efforts to develop appropriate policies and accurate strategies by making the most accurate analyzes highlight the analysis of these markets, which differ significantly from one-sided markets. While analyzing two-sided markets, the pricing strategies and the impact of regulatory policies are the most prominent issues. The interaction between buyers and sellers in online purchases, developers and users in software, callers and those receiving calls in telecommunications, advertisers in the media and the readers and viewers of those advertisements, and buyers and retailers in electronic payments can differentiate market behavior from general assumptions. Both companies and policymakers should take this difference into account in order to achieve their expectations (Rochet and Tirole 2003; Armstrong 2006; Caillaud and Jullien 2003; Evans and Schmalensee 2005).

The Mobile telecommunications market is one of the most important examples of two-sided markets. In this market, which has a demand for both making and receiving calls, mobile operators respond to the demands simultaneously with interconnection service by showing a two-sided market behavior. Unlike the classic two-sided markets, mobile telecommunications market subscribers can be found on both sides of the market, sometimes as a caller and sometimes as the one who is being called. In other words, there is a high level of overlap between the groups in the market (Gao 2018; Valletti 2006). Due to this situation, the effects of pricing strategies and regulations in the mobile telecommunications market are highly important in the analysis of two-sided markets. As an example of this special case, it is discussed in many studies that if the mobile interconnection rates are reduced centrally the mobile communication prices that the end user faces in the market might increase due to the waterbed effect (Schiff 2008; Growitsch, Marcus and Wernick 2010; Lee and Lee 2012). The aim of this study is to analyze the effect of the change in mobile interconnection rates on the market prices in the context of the waterbed effect by considering mobile telecommunications market as an example of a two-sided market. By using the 41 quarter period data of 21 OECD countries between 2005 and 2015, the impact of mobile interconnection rates reductions on the prices faced by end-users is analyzed empirically by the Common Correlated Effects Mean Group (CCEMG) method, a type of Common Correlated Effects (CCE) approach. After a brief introduction in the first section of the study, the second part focuses on two-sided markets. In the third chapter, the mobile telecommunications market is examined as a example of a two-sided market and the waterbed effect is discussed. In the fourth section of the study, a literature review is included and in the fifth section, empirical analysis is done and the results are revealed. In the last section, the findings of the empirical analysis are evaluated based on the purpose of the study.

1.TWO-SIDED MARKETS

The two-sided markets theory, which began to take place in the economic literature after the study of Rochet and Tirole (2003, 2006) and was analyzed in many studies such as Armstrong (2006), Caillaud and Jullien (2003), Evans and Schmalensee (2005), Eisenmann, Parker and Alstyne (2006, 2011a, 2011b). There are no common approaches to the definition and characteristics of the two-sided markets which response to the demands of more than one group of consumers with different demand structures simultaneously. Rochet and Tirole (2003) define the two-sided markets by focusing on the price structure and the difference in the sensitivity of demand between the total price level and to the pricing structure. They emphasize that the sign of two-sided markets is the fact that market participation and transaction volume in the market will be affected by price structure although the price level does not change[1]. On the other hand, Armstrong (2006) focuses on the inter-group externality in the two-sided market's definition and argues that two-sided markets will be the case if one of the parties joins the market and the trading volume that is generated in the market by this party changes the value attributed to the other side of the market. Wright (2004) focuses on the cross-group externalities between them, emphasizing the fact that groups with different demand structures are influenced by each other's decisions. Furthermore, Evans (2003) argues that the platforms[2] serve similar to matchmakers and bring two sides together. When all the definitions are compiled together, it is possible to mention the three basic properties of two-sided markets (OECD 2009);

[1] While the total price level collected by the platform refers to the weighted sum of the prices that the two parties face in the market, the pricing structure reveals how this total price level is shared between the two parties.

[2] In supplying goods and / or services by combining two sides in two-sided markets, the supplier is generally expressed by the concept of "platform" rather than the "firm".

- There should be two consumer groups with different demand structures and the platform should provide them with goods / services simultaneously.
- There should be indirect externalities between these groups.
- The applied price structure should not be neutral in influencing demand.

Newspapers, one of the most classic examples of two-sided markets, may be considered for a better understanding of the definitions. Readers and advertisers in newspapers form two sides of the market. According to the definition of Rochet and Tirole (2003), when pricing structure is changed by lowering the price of the readers and raising the prices paid by the advertisers, the number of readers will increase due to the decrease in prices while the total price level paid by readers and advertisers remains unchanged. Consequently, advertisers will capture more opportunities to reach consumers despite rising costs. Therefore, the volume of participation and trading in the market will increase for both sides. According to Armstrong's (2006) definition, an increase in the number of readers of the newspaper will increase the value that advertisers attribute to that newspaper. In other words, the amount that the advertisers would be willing to pay is a function of the newspaper's number of subscribers. The more readers the newspaper reaches, the more valuable it will be for the advertisers.

In two-sided markets, pricing strategies and regulations are the two most important issues. The platforms price the parties to which they provide value-added goods/services through the membership fees and/or usage fees they receive. While pricing the groups, the platform, takes into account the elasticity of the two sides, the direction and size of the indirect group externalities, and the level of competition in the market, and accordingly can go to equal pricing or sometimes can price one side far below the cost and the other side much higher than the cost. Sometimes it can even make negative pricing with bonuses and rewards depending on the transaction volume. In particular, the party making more externalities is charged lower, while the other party who earns from this externality is charged higher (Evans and Schmalensee 2005; Eisenmann, Parker and Alstyne 2006; Hagiu 2009; Weyl 2010; Brito, Pereira and Vareda 2013). The complex structure of the two-sided markets also shows itself in state regulations. Clearly determining the effect of price changes on the welfare of these markets is not as easy as in one-sided markets. In addition, it is very difficult to calculate the costs of intervention in these markets as well as to determine the social optimum and how to achieve this point (Brito, Pereira and Vareda 2013; Evans 2003; Rysman 2009; Valverde, Chakravorti and Fernandez 2009). While responding to the need for regulation in these special markets where the impact response results cannot be fully realized, it is necessary to redefine the concepts that are important for the market structure such as market, failure, excessive and destructive pricing and entry barriers (Doganoglu and Wright 2006; Armstrong and Wright 2007; Evans 2003; Wright 2004).

2.MOBILE TELECOMMUNICATIONS MARKET AND THE WATERBED EFFECT

The Mobile telecommunications market is one of the most special examples of the two-sided markets with the interconnection service that operators provide to subscribers who request to make and receive calls. Considering the two-sided markets analyzes discussed in the literature, it can be said that classical examples such as media, card payment, and video games platforms have been used extensively. In these markets, the parties are separate from each other and do not overlap too much. However, there is a high level of overlap between the two parties in the mobile telecommunications market. In other words, all subscribers can be both callers and those receiving calls. This brings the mobile telecommunications market, which is a very special market types to a more specific position in two-sided markets. The mobile telecommunications market shows three basic features of two-sided markets. The two groups, who are demanding incoming and outgoing calls, are brought together and served simultaneously through the networks of the operators which are examples of platforms. The number of subscribers in an operator base clearly increases the value of the platform for other subscribers. Finally, if we consider the fact that the person receiving the call is charged lower or higher compared to the person who is making the call, then this will clearly affect the participation in the market, in other words, the penetration rate as well as the average number and duration of calls.

For the realization of mobile communication, an interconnection service must be provided between the operators and the price requested for this service is called mobile interconnection rates (Channer 2010). In terms of interconnection, the mobile interconnection rates can be determined far from competitive prices, since each operator is monopolized in its own network. Regulatory authorities centrally determine mobile interconnection rates or set various limits to these rates. However, many studies in the literature suggest that the reduction of the mobile interconnection rates will result in an increase of the prices that the subscribers face in the market on the contrary of the expectations due to the waterbed effect. The waterbed effect describes the interdependence between prices in the two-sided markets. This effect can be explained as the centralized intervention of the price of a product of a company that sells more than one product affects other unregulated product prices (Harbord and Pagnozzi 2010; Armstrong and Wright 2009; Schiff 2008). Although operators agree that the mobile interconnection rates are above the costs, they argue that the income from the mobile interconnection rates as a characteristic of the typical two-sided markets generates subsidies for the acquisition and protection of mobile subscribers. The subscribers' earnings as a result of lower mobile interconnection rates will be lost by higher subscription and talking fees due to the waterbed effect. The degree of this interaction may vary depending on many factors, such as the intensity of competition, market dynamics, development level of the market, and the price elasticity of demand (Dobson and Inderst 2007; Genakos and Valletti 2011; Bodammer 2009).

3.LITERATURE REVIEW

Although the analysis of the markets defined as two-sided markets is quite old, the two-sided markets' literature has started to develop with the pioneering works of Rochet and Tirole (2003), Armstrong (2006), Caillaud and Jullien (2003). The theoretical infrastructure was then developed by Evans and Schmalensee (2005), Eisenmann, Parker and Alstyne (2006, 2011a). In addition to the theoretical developments, the empirical literature on two-sided markets, the market power of the platforms (Argentesi and Filistrucchi 2007; Song 2011), the effects of the platform mergings (Chandra and Collard-Wexler 2009; Filistrucchi, Klein and Michielsen 2012; Jeziorski 2012), the pricing structure (Kaiser and Wright 2006) and the forecasts of the platform demands (Lee 2011) were discussed in various studies. The effects of regulatory regimes in the two-sided markets (Evans, 2003; Wright, 2004; Rysman 2009; Valverde, Chakravorti and Fernandez 2009) were analyzed and the waterbed effect in mobile telecommunications market was also investigated and analyzed empirically with several studies such as Schiff (2008), Cunningham, Alexander and Candeub (2010), Lee and Lee (2012), Genakos and Valletti (2011, 2015).

Rochet and Tirole (2003) provide a model for analyzing competition in the credit card market as a two-sided markets example, consisting of consumers on one side and retailers on the other side. They investigate different pricing structures and end-user surpluses for platforms that seek to maximize profits and non-profit structures and compare their output with monopolist and Ramsey pricing results. Caillaud and Jullien (2003) take matching websites, such as friendship and real estate, as two-sided markets examples and analyze price competition with the help of linear demand and Bertrand pricing model. Armstrong (2006) focuses on the impact of network externality, and for two-sided markets defines three different situations; monopoly platform, a situation where each group can choose a single platform and thirdly a situation that a group can participate in all platforms, then presents theoretical models for these situations. According to Armstrong, the main determinants of the equilibrium prices are the relative dimensions of cross-network externalities, how the prices are paid and the restrictions on participation to the platform.

In his study, Schiff (2008) discusses the waterbed effect, which he argues arises from the motives for profit maximization in price regulations. This effect occurs when the marginal income and the marginal cost depend on the amount on the other side. Cunningham et al. (2010) use the impact of mobile interconnection rates on the consumer base on the other hand Lee and Lee (2012) use the relationship between asymmetric mobile interconnection rates and mobile retail prices to do empirical analysis and reveal the waterbed effect. Two important studies of the the waterbed effect literature were conducted by Genakos and Valletti (2011, 2015). Genakos and Valletti (2011) found that a reduction in mobile interconnection rates increases the market price. However, in their later studies (2015), for more countries and for a longer period they determined that the waterbed effect disappears over time.

4.EMPIRICAL ANALYSIS

In this empirical study, the mobile telecommunications market is considered as the two-sided markets example and the relationship between the end user's price in the market and the mobile interconnection rates determined by the central authority, in general, is analyzed in the waterbed effect context. The market analysis is deepened by adding income and quantity which are effective factors in determining the market price. Taking into consideration the OECD countries studied, the period of analysis and the method used, this study distinguishes itself from all other studies that address the mobile telecommunications markets and observe the impact of the waterbed effect and therefore make a significant contribution to the empirical literature on market analysis.

4.1.Data and Model

In this study, empirical analysis is carried out by Common Correlated Effects Mean Group (CCEMG) method, which is a type of Common Correlated Effects (CCE) approach, using 41 quarterly balanced panel data from the first quarter of 2005 to the first quarter of 2015 of 21 OECD[3] countries. In the study, the function (1) that is put forward by Shew (1994) and developed by McCloughan and Lyons (2006) is followed;

$$P = f\left(S, M, R, Q \right) \tag{1}$$

Here P represents the price that the end user faces in the mobile telecommunications market; S represents the quality of service; M, the characteristics of the relevant market; R regulatory intervention and Q is the quantity.

The function (1) is re-arranged considering Lyons (2006), McCloughan and Lyons (2006), Genakos and Valletti (2011) studies. Representing the price, average revenue per minute, representing the price and cost of other goods, mobile interconnection rates, representing the revenue, per capita gross domestic product, representing the amount and development level of the market, the number of subscribers and penetration rate will be used. The models that will be estimated to analyze how the price in the mobile telecommunications market is determined in the waterbed effect context are as follows;

$$Model\ I \quad : RPM_{it} = MTR_{it} + GDP_{it} + NS_{it}$$

$$Model\ II \quad : RPM_{it} = MTR_{it} + GDP_{it} + PEN_{it} \tag{2}$$

In these models, RPM, which represents the average incomes of the operators per minute, is obtained by dividing total revenue by total traffic. MTR, which expresses mobile interconnection rates, is obtained by the average of the fees collected by the operators from each other per minute for off-net mobile calls. GDP, which represents income per capita, is derived by dividing the total gross domestic product by the population in the relevant period. The NS, which represents the total number of subscribers, is obtained by the sum of the subscribers registered to the operators in that country in the relevant period. PEN, which expresses the mobile penetration rate in the country, is obtained by dividing the total number of mobile lines by the total population. Two different models are estimated by incorporating NS and PEN into the model separately as two variables that represent the quantity and development of the market and act together significantly. GDP and NS variables are formed by taking the logarithm of related values. The monetary values RPM, MTR and GDP are calculated as US Dollars by taking into consideration the foreign exchange rates in each country in the relevant period. Data are compiled from the regulatory authorities of the countries, mobile operators, ITU, CTIA, GSMA, OFCOM, and OECD.

Table 1. Variable Definitions and Summary Statistics

Variables	*Definitions*	*Mean*	*Std. Dev.*	*Min.*	*Max.*
RPM	Revenue per minute	0.171	0.084	0.026	0.570
MTR	Mobile interconnection rates	0.079	0.055	0.009	0.312
GDP	Per capita gross domestic product	4.524	0.268	3.811	5.029
NS	Total number of subscribers	4.324	0.441	3.533	5.061
PEN	Mobile penetration rate	1.178	0.259	0.393	1.860

[3] In this study Australia, Austria, Belgium, Chile, Denmark, Finland, France, Germany, Greece, Israel, Italy, Korea, Mexico, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey and the UK mobile telecommunications markets were analyzed. OECD countries, whose data cannot be obtained in accurately and who are using the receiving party pays system in the mobile telecommunications market, are not included in the study to obtain more reliable and consistent results.

In this empirical analysis, based on basic economic acceptances, two-sided markets characteristics and mobile telecommunications market specific characteristics, expectations are as follows;

i. The relationship between the mobile communication price and the mobile interconnection rates can be obtained in the same or opposite direction. If the corresponding coefficient is negative (-) then it is interpreted that the waterbed effect in the mobile communication service is observed. If it is positive (+), then the mobile interconnection rates will be considered as a cost element in the mobile communication service.

ii. The relationship between prices and income is expected to be in the same direction, which means the coefficient is expected to be positive (+). The increase in income will increase the willingness to pay, which will be reflected in the prices of the supplier. In other words, as income increases, prices are expected to rise.

iii. The relationship between the prices and the number of mobile subscribers is expected to be the opposite, that means a negative (-) coefficient. The increase in the number of subscribers in the mobile telecommunications market, where fixed costs are quite high and varying costs are low, will reduce the average cost per subscriber, which will lead to lower prices. Moreover, an inverse relationship between quantity and prices in the two-sided markets is mainly expected from cross-externality and cross-subsidies.

iv. The relationship between the prices and the penetration rate is expected to be the opposite, in other words, a negative (-) coefficient is expected. First of all, the increase in the penetration rate means that the number of subscribers in the market increases and that the share of it in the population increases getting close to saturation. In this case, price competition increases and allows prices to fall. In addition, since the cross-externality and cross-subsidy effect will be observed through the penetration rate too, the corresponding coefficient is expected to be negative (-).

4.2.Econometric Methodology

For the purposes stated above, the models numbered (2) are estimated by the Common Correlated Effects Mean Group (CCEMG) estimator. However, before the estimation of the parameters, the existence of the correlation between the cross section units, the homogeneity of the slope parameters, unit roots, and the cointegration relationship should be analyzed. In the panel data analysis, the existence of correlation between the cross section units forming the panel and whether the slope coefficients are homogeneous according to the units, affect the unit root tests, cointegration tests and cointegration estimation methods to be used in the analysis. For reliable and consistent results, empirical analysis is performed by taking these interactions into account and a methodological summary of these steps is given below.

4.3.Cross-Sectional Dependence and Homogeneity Tests

For panel data analysis, cross-sectional dependency should be tested both on a variable basis and on a model basis for the selection of unit root tests to be used in the analysis before cointegration tests and parameter estimations are made. In this study, cross-sectional dependency will be analyzed by LM test (Breusch and Pagan 1980), scaled LM test (Pesaran 2004), CD test (Pesaran 2004) and bias-adjusted LM test (Pesaran, Ullah and Yamagata 2008). The LM test (Breusch and Pagan 1980) is valid when the cross-sectional dimension (N) is relatively small and the time dimension is large enough (T> N). The scaled LM test (Pesaran 2004) has been demonstrated as a scaled version of the LM test for situations where both the cross-sectional size (N) and the time dimension (T) are large. CD test (Pesaran 2004) is an adaptation of Breusch and Pagan (1980) LM test for situations where the size of the cross-section (N) is large and time dimension (T) is small. The Bias-adjusted LM test is developed as an alternative test to overcome the shortcomings of Breusch and Pagan (1980) LM test by Pesaran, Ullah, and Yamagata (2008).

The following hypotheses numbered (3) can be written for all these four tests;

$$H_0 : \rho_{ij} = corr(u_{it}, u_{jt}) = 0 \ \ (i \neq j) \qquad H_1 : \rho_{ij} = corr(u_{it}, u_{jt}) \neq 0 \ \ (i \neq j) \tag{3}$$

In these hypotheses ρij i. and j. represent the correlation coefficient between the residues of the cross-section unit. At this point, while the basic hypothesis shows the absence of correlation between the cross-sectional units, the alternative hypothesis states the cross-sectional dependence.

Another important factor influencing the selection of cointegration tests and estimation methods is whether the slope coefficients in the cointegration equation are homogenous to units. This question should be answered through the homogeneity test. In this study, the homogeneity tests which are the standardized version of the Swamy test and recommended by Pesaran and Yamagata (2008) will be used. Pesaran and Yamagata (2008) test the homogeneity of slope parameters with two different test versions. The first version ($\hat{\Delta}$), proposed for large samples takes advantage of the Swamy test statistic and the second version ($\tilde{\Delta}$adj)proposed for small samples is based on a modified format of Swamy statistic, where regression standard errors for individual cross section units are calculated by pooled constant effects estimator rather than the OLS estimator. In this context, the basic hypothesis expresses the homogeneity of the slope parameters and the alternative hypothesis is structured on the fact that these parameters are heterogeneous. These test hypotheses can be expressed as follows:

$$H_0 : \beta_i = \beta \quad \textit{for all “i”s} \qquad H_1 : \beta_i \neq \beta_j \tag{4}$$

4.4.Panel Unit Root Test

In order to determine whether there is a long-term relationship between the series, the stationary of the series should be investigated first. Since the first generation unit root tests do not take into account the cross-sectional dependence, second-generation unit root tests that take into account the cross-sectional dependence are preferred. In this study, the CADF panel unit root test developed by Pesaran (2007) will be used. This test is a simple alternative to the standard ADF test, which is augmented by the cross-sectional averages and first differences of the delayed levels of the individual series. The most important feature of this test is that it considers the cross-sectional dependence and gives reliable results when it is N> T or T> N.

The CADF panel unit root test is based on the following model;

$$Y_{it} = (1-\phi_i)\mu_i + \phi_i Y_{i,t-1} + u_{it} \tag{5}$$

In the equation (5), as i=1…,N; t=1…,T ; Y_{it} is the i. cross-section unit observation in period t and $u_{it}$is the error term. $u_{it}$with a single factor structure, can be expressed as equation (6);

$$u_{it} = \gamma_i \, f_t + e_{it} \tag{6}$$

In the equation (6), f_t, is the unobserved common effect and eit is the individual specific error. The equation (5), can be rewritten as follows:

$$\Delta Y_{it} = \alpha_i + \beta_i Y_{i,t-1} + \gamma_i \, f_t + \varepsilon_{it} \tag{7}$$

In the equation (7) , $\alpha_i = (1-\phi_i)\mu_i$, $\beta_i = -(1-\phi_i)$ and $\Delta Y_{it} = Y_{it} - Y_{i,t-1}$. The hypotheses to be used to test the stationary of the series can be expressed as follows:

$$H_0 : \beta_i = 0 \qquad H_1 : \beta_i < 0, \quad i = 1,2,...,N_1, \\ \beta_i = 0, \quad i = N_1+1, N_2+2,...,N \tag{8}$$

4.5.Cointegration Tests

Before the estimation of the model coefficients, finally, a cointegration test is used to determine whether there is a stationary relationship between the series, in other words, it is tested whether there is a long-term relationship or not. Second-generation cointegration tests should be preferred considering the existence of a correlation between the cross-sectional units as the first-generation cointegration tests are regarded as not providing reliable results in the case of cross-sectional dependency. In this study, the Durbin Hausman (DH) cointegration test developed by Westerlund (2008) will be used, which takes into account the cross-sectional dependence and also allows heterogeneity of the slope coefficients. In order to be able to perform the DH cointegration test, the dependent variable must be non-stationary, i.e. it should be I (1), while the independent variables can be I (0) or I (1).

The DH test has two dimensions, the first one is panel size and the other one is group size. The assumption of the DH panel (DHp) test is that the autoregressive parameter is common to each section. With this assumption, when the null hypothesis is rejected, cointegration is accepted to exist for all sections. The DH group (DHg) test allows the autoregressive parameter to change between sections under an alternative hypothesis. Therefore, the rejection of the null hypothesis indicates that there is cointegration for some sections (Westerlund 2008). DHp and DHg test statistics and hypotheses are as follows;

$$DH_p = \hat{S}_N(\tilde{\phi} - \hat{\phi})^2 \sum_{i=1}^{N}\sum_{t=2}^{T}\hat{e}_{i,t-1}^2 \qquad DH_g = \sum_{i=1}^{N}\hat{S}_i(\tilde{\phi}_i - \hat{\phi}_i)^2 \sum_{t=2}^{T}\hat{e}_{i,t-1}^2$$

$$H_0 : \phi_i = 1 \ \ (for\ all\ \text{“}i\text{”}s) \qquad H_0 : \phi_i = 1 \ \ (for\ all\ \text{“}i\text{”}s)$$

$$H_1 : \phi_i = \phi\ ve\ \phi < 1 \ \ (for\ all\ \text{“}i\text{”}s) \qquad H_1 : \phi_i < 1 \ \ (at\ least\ for\ some\ \text{“}i\text{”}s) \tag{9}$$

4.5.Estimation of Panel Cointegration Coefficients

After determining the cointegration in the panel data set used for empirical analysis, the long-term cointegration coefficients are estimated by selecting the appropriate method for the findings previously obtained. In this study, Common Correlated Effects (CCE) method which considers cross-sectional dependence and homogeneity and developed by Pesaran (2006) will be used in the prediction of the model. The CCE method, which provides much more effective estimators compared to the methods that do not consider the cross-sectional dependence, gives consistent results when the series are stationary, difference stationary and co-integrated. Pesaran (2006) revealed two types of estimators to be used in cases where the slope coefficients for the CCE method are homogeneous and heterogeneous. The first is the Common Correlated Effects Pooled (CCEP) estimator, which assumes homogeneity of slope coefficients, and the other is the Common Correlated Effects Mean Group (CCEMG) estimator, which assumes that the slope coefficients are heterogeneous. Here the CCEMG estimator will be used to take into account the heterogeneity of the slope parameters.

The CCE method is based on the heterogeneous panel data model numbered (10);

$$y_{it} = \alpha_i^{'} d_t + \beta_i^{'} x_{it} + u_{it} \ \ (u_{it} = \gamma_i^{'} f_t + e_{it}) \tag{10}$$

In these equations, dt and ft show common effects that can be observed and cannot be observed.

In the CCEMG estimator, the long-term parameters are obtained by calculating the arithmetic mean (11) of the coefficients of each cross-section.

$$\hat{b}_{CCEMG} = \frac{1}{N}\sum_{i=1}^{N}\hat{b}_i \tag{11}$$

$\hat{b}_i$ denotes the calculated CCE estimate for each section unit and is calculated as in equation (12)

$$\hat{b}_i = (X_i^{'}\bar{M}_w X_i)^{-1} X_i^{'}\bar{M}_w Y_i \ \ (Y_i = Y_{i1}, Y_{i2}, ..., Y_{iT},) \tag{12}$$

Therefore, in this method, the cointegration coefficients of each section are estimated and then the cointegration coefficient of the panel is calculated by taking the arithmetic mean of the coefficients of the sections.

5.EMPIRICAL ANALYSIS RESULTS

The results obtained from the empirical analysis of the 21 OECD countries for 41 quarter period balanced panel data between the years 2005 and 2015 are shared and interpreted below in the order discussed in the econometric methodology.

In the panel data analysis, the correlation between the cross-section units forming the panel is important for the methods to be used later in the empirical analysis. For this reason, firstly, the cross-sectional dependence of the variables and models used in the model has been tested and the results are shared in Table 2. According to four shared test results, the hypothesis H0, which states that there is no cross-sectional dependence for all variables and models, is rejected at the significance level of 0.01. That means, there is a correlation between the cross section units. This result is in line with the expectation that the mobile telecommunications markets, which are rapidly globalizing and which are the most influential factors on globalization and the most influenced factors by globalization, will create a dependency between countries.

Table 2. Cross-Sectional Dependency Test Results

Tests	*RPM*	*MTR*	*GDP*	*NS*	*PEN*	*Model I*	*Model II*
Breusch-Pagan LM	343.383	822.779	1667.711	302.171	340.043	778.474	817.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Pesaran (2004) CD LM	6.069	29.901	71.129	4.498	6.345	27.739	29.619
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Pesaran (2004) CD	-1.767	-3.087	3.124	-2.843	-3.058	6.868	7.194
	(0.039)	(0.001)	(0.001)	(0.002)	(0.001)	(0.000)	(0.000)
Bias-adjusted LM	29.175	21.646	41.048	67.905	21.012	47.543	35.414
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Note: the values in ( ) are probability (p) values.

After testing the dependency between the cross-sections, it was tested whether the slope coefficients in the cointegration equation are homogenous to the units as an element affecting the cointegration tests and the selection of estimation methods. This test was carried out following the study of Pesaran and Yamagata (2008) and the results were shared in Table 3. When considering the results of two versions calculated for both models, it is seen that H0 hypothesis expressing homogeneity of slope parameters was rejected at 0.01 significance level. In other words, the slope parameters differ according to the countries. This result is fully consistent with the expectations given the specific characteristics of the countries and the fact that the mobile telecommunications markets have different levels of structure and development.

Table 3. Homogeneity Test Results

Models	*Tests*	*Test Statistic*
Model I	$\tilde{\Delta}$	28.889 (0.000)
	$\tilde{\Delta}_{adj}$	30.411 (0.000)
Model II	$\tilde{\Delta}$	32.438 (0.000)
	$\tilde{\Delta}_{adj}$	34.146 (0.000)

Note: the values in ( ) are probability (p) values.

The unit root test will be performed before examining the existence of a long-term relationship between the series to be used in the analysis and thus it will be investigated how stationary the series are. As the cross-sectional dependence was detected in the previous tests, the second-generation unit root test CADF panel unit root test, which takes into account the cross-sectional dependence, was used and the results were shared in Table 4. According to the results of the test, it is seen that the dependent variable and the explanatory variables other than MTR contain unit root at the level. It is seen from the results in Table 4 that all the variables with the first differences were become stationary at 0.01 significance level.

Table 4. CADF Panel Unit Root Test Results

	Variables	Test Statistic	lag	Critical Value (%1)	p- value
Level	RPM	-2.020	2	-2.300	0.112
	MTR	-2.348	2	-2.300	0.002
	GDP	-1.342	2	-2.300	0.981
	NS	-1.724	2	-2.300	0.590
	PEN	-1.464	2	-2.300	0.932
First Difference	RPM	-2.702	2	-2.300	0.000
	MTR	-3.141	2	-2.300	0.000
	GDP	-3.051	2	-2.300	0.000
	NS	-2.766	2	-2.300	0.000
	PEN	-2.910	2	-2.300	0.000

Before the estimation of the coefficients, a cointegration test is performed and the existence of a stationary relationship between the series, in other words, the existence of a long-term relationship is tested for both models. In this cointegration analysis, second generation DH cointegration test is preferred considering the existence of correlation between the cross section units based on the findings obtained previously. As for the variables used herein, the dependent variable must be non-stationary, which means I(1), while the independent variables can be I(0) or I(1), in order for the DH cointegration test to be performed. The DHg and DHp cointegration test results obtained in both models are shown in Table 5. When the obtained p-values are examined, it is seen that the hypothesis of H0 is rejected for both group and panel statistics at the significance levels of both 0.05 and 0.10 and it is concluded that there is a long-term relationship between the variables.

Table 5. Cointegration Test Results

Models	Durbin-Hausman	t-statistic	p-value
Model I	DH_g Statistic	-1.700	0.045
	DH_p Statistic	-1.749	0.040
Model II	DH_g Statistic	-1.409	0.079
	DH_p Statistic	-1.630	0.051

According to the above test result, after the cointegration is demonstrated, the long-term cointegration coefficients can be estimated by selecting the appropriate method for the previously obtained findings. In this study, CCEMG method, which is developed by Pesaran (2006) and which takes into account the cross-sectional dependence and which is preferred in case of heterogeneity of the slope parameters, is used in the estimation of the model. Table 6 shows the estimation results of cointegration coefficients and p-values in parentheses. All explanatory variables were statistically significant at 0.01 and 0.05 significance level in both models.

The coefficient of GDP used to represent the income was positive in accordance with the expectations. That means income and prices move in the same direction. For example, an increase of 1% in GDP will increase RPM by 0.38 units according to Model I and 0.35 units by Model II. The coefficients of the number of subscribers used in the first model and the penetration rate explanatory variables used in the second model were negative according to the expectations. Therefore the price and the amount move in opposite directions as expected. According to the first model, a 1% increase in NS will reduce the RPM by 0.20 units. According to the second model, a change of one unit in the PEN will affect the RPM by 0.10 units in the opposite direction.

Table 6. Estimation Results Of CCEMG Estimator

Models		*MTR*	*GDP*	*NS*	*PEN*	*cons*
Model I	***RPM***	0.320	0.380	-0.202	-	0.030
		(0.019)	(0.000)	(0.050)		(0.952)
Model II	***RPM***	0.257	0.355	-	-0.101	-0.182
		(0.018)	(0.000)		(0.002)	(0.194)

Note: the values in ( ) are probability (p) values.

As it is known, the main purpose of the study is to analyze the formation of price in terms of waterbed effect in mobile telecommunications market which is considered as a two-sided markets sample. For this purpose, MTR was selected and used as the explanatory variable. In Table 6, when the predicted results of the two models are examined, MTR is obtained statistically significant at 0.05 significance level with a positive coefficient. A change of 1 (one) unit in the MTR will change the RPM in the same direction, 0.32 units according to the first model and 0.25 units according to the second model. According to the waterbed effect theorem, it is expected that the MTR and RPM will move in the opposite direction, therefore the coefficient of the MTR would be negative (-). However, the relevant coefficients here are obtained positively. As previously stated, obtaining a positive (+) coefficient is not exactly opposite to the predictions. This situation shows that the MTR is considered as a cost factor in determining the price that the end-user faces. As a result, considering the period analyzed for the related country group, the waterbed effect in the mobile telecommunications market could not be determined and MTR acted as a cost factor and changed the prices in the same direction.

CONCLUSION

In order to develop appropriate policies and accurate strategies, it is important to examine the two-sided markets, which differ significantly from one-sided markets. Pricing strategies and regulations in these markets are the two most important issues. In these markets, both the platforms and policymakers need to take steps that take into account the differences in order to achieve results that are appropriate to their expectations. Platform groups should go to pricing by taking into account the elasticity of the two sides, the direction and size of the indirect group externalities, and the level of competition in the market. In these markets, determining the clear effect of pricing strategies on welfare is not as easy as in one-sided markets. It is very difficult to determine the costs of a regulation and to determine its social optimum as well as determining how to achieve this point.

Mobile telecommunications market, which is one of the most important examples of two-sided markets, responds to the requests of incoming and outgoing calls of its subscribers. Unlike conventional two-sided markets, there is a high level of overlap between groups, since subscribers in the mobile telecommunications market sometimes want to make calls and sometimes want to receive calls. Due to this situation, the pricing strategies and regulations in the mobile telecommunications market have a special place in the two-sided markets analysis. A central reduction on the mobile interconnection rates that operators receive for interconnection service can demonstrate the waterbed effect, causing an increase in mobile communication prices that the end user faces in the market. In this study, by considering mobile telecommunications market as an example of two-sided market, the effect of the change in the mobile interconnection rates, on the market price has been analyzed in the context of the waterbed effect. CCEMG method was preferred in this estimation and 41 quarter period data of 21 OECD countries between the years 2005 and 2015 is used.

In the empirical analysis, the cross-sectional dependence of the variables and models forming the panel was tested and a correlation was found between the countries which indicates there is a dependence between the countries. In addition, by homogeneity test, it is concluded that slope parameters are differentiated according to countries. The long-term relationship between the series to be used in the analysis is demonstrated by the cointegration test. Based on these findings, the appropriate method is chosen and the long-term cointegration coefficients are estimated. The coefficients are consistent with expectations and statistically significant.

According to the results, the waterbed effect could not be detected in the mobile telecommunications market in the period analyzed for the related country group and mobile interconnection rates acted as a cost factor and changed the prices in the same direction. The coefficient of income variable is positive and the expectation that the increase in income would increase the price is met. The coefficients of explanatory variables representing quantity, which are the number of subscribers and the penetration rate, are found to be negative as expected and they are observed to act in accordance with economic expectations and two-sided market characteristics. This study can be developed by approaches considering structural breaks in the examination of these markets which are subject to government regulation to a wide extent.

REFERENCES

Argentesi, Elena and Filistrucchi, Lapo, (2007) "Estimating Market Power in a Two-Sided Market: The Case Of Newspapers", Journal of Applied Econometrics 22(7): 1247-1266.

Armstrong, Mark, (2006) "Platform Competition in Two-Sided Markets", RAND Journal of Economics 37(3): 668-691.

Armstrong, Mark and Wright, Julian (2009) “Mobile Call Termination”, Economic Journal, 119(538): 270– 307.

Armstrong, Mark and Wright, Julian, (2007) "Two-Sided Markets, Competitive Bottlenecks and Exclusive Contracts", Economic Theory 32(2): 353-380.

Bodammer, Imme, (2009) “The Waterbed Effect Explained in Relation to Roaming: An Economics Perspective” , https://pdfs.semanticscholar.org/presentation/b4b0/c54778e65ec0e866fd2fd9611242688c8ad5.pdf (20 May 2018).

Breusch, Trevor Stanley and Pagan, Adrian, (1980) “The Lagrange Multiplier Test And its Applications To Model Specification in Econometrics” , The Review of Economic Studies 47(1): 239-253.

Brito, Duarte, Pereira, Pedro and Vareda, João, (2013) "Network Neutrality Under ISP Duopoly: On The Ability To Assign Capacity", Working Papers, University of Evora, CEFAGE-UE .

Caillaud, Bernard and Bruno, Jullien, (2003) "Chicken & Egg: Competition Among Intermediation Service Providers", RAND Journal of Economics 34(2): 309-328.

Chandra, Ambarish and Allan, Collard-Wexler, (2009) "Mergers in Two-Sided Markets: An Application to the Canadian Newspaper Industry", Journal of Economics and Management Strategy 18(4): 1045-1070.

Channer, Evona, (2010) “Staff opinion on the competitive dynamics of call termination provision. Staff Report” , Fair Trading Commission. https://jftc.gov.jm/wp-content/uploads/2017/10/Competitive-Dynamics-of-Call-Termination-Provision.pdf (10 May 2018).

Cunningham, Brendan, Peter, Alexander and Adam, Candeub, (2010) “Network Growth: Theory And Evidence From The Mobile Telephone Industry” , Information Economics and Policy 22(1): 91-102.

Dobson, Paul and Inderst, Roman (2007) “Differential Buyer Power And The Waterbed Effect: Do Strong Buyers Benefit Or Harm Consumers?”, European Competition Law Review. 28.

Doganoglu, Toker and Julian, Wright, (2006) "Multihoming And Compatibility", International Journal of Industrial Organization 24(1): 45-67.

Eisenmann, Thomas, Parker, Geoffrey and Marshall, Van Alstyne, (2006) "Strategies For Two-Sided Markets", Harvard Business Review 84(10): 92-98.

Eisenmann, Thomas, Parker, Geoffrey and Marshall, Van Alstyne, (2011a) "Opening Platforms: How, When And Why?" , Platforms, Markets and Innovation 6: 131-139.

Eisenmann, Thomas, Parker, Geoffrey and Marshall, Van Alstyne, (2011b) "Platform Envelopment". Strategic Management Journal, 32(12): 1270-1285.

Evans, David, (2003) "Antitrust Economics of Multi-Sided Platform Markets", Yale Journal on Regulation 20: 325-431.

Evans, David and Richard, Schmalensee, (2005) "The Industrial Organization Of Markets With Two-Sided Platforms", Working Paper Available at SSRN: https://ssrn.com/abstract=786627 or http://dx.doi.org/10.2139/ssrn.786627.

Filistrucchi, Lapo, Klein,Tobias and Thomas, Michielsen, (2012) "Assessing Unilateral Merger Effects in a Two-Sided Market: An Application to the Dutch Daily Newspaper Market", Journal of Competition Law and Economics 8(2): 297-329.

Gao, Ming, (2018) “Platform Pricing In Mixed Two-Sided Markets” , International Economic Review 59: 1103-1129.

Genakos, Christos and Tommaso, Valletti, (2015) “Evaluating A Decade Of Mobile Termination Rate Regulation” , Economic Journal, 125(586).

Genakos, Christos and Tommaso, Valletti, (2011) “Testing The ‘Waterbed’ Effect in Mobile Telecommunications” , Journal of the European Economic Association 9(6):1114–42.

Growitsch, Christian , Marcus, Scott and Wernick, Christian, (2010) “The Effects Of Lower Mobile Termination Rates (MTRs) On Retail Price And Demand” , Communications and Strategies 80:119-140.

Hagiu, Andrei, (2009) "Two-Sided Platforms: Product Variety and Pricing Structures", Journal of Economics and Management Strategy 18(4): 1011-1043.

Harbord, David and Pagnozzi, Marco (2010. “Network-Based Price Discrimination And ‘Bill-And-Keep’ Vs. ‘Costbased-Regulation Of Mobile Termination Rates”, Review of Network Economics. 9(1).

Jeziorski, Przemys, (2012) "Effects Of Mergers in Two-Sided Markets: Examination Of The US Radio Industry", Working Paper.

Kaiser, Ulrich and Julian, Wright, (2006) "Price Structure in Two-Sided Markets: Evidence From The Magazine Industry", International Journal of Industrial Organization 24(1): 1-28.

Lee, Jongyong and Lee, Duk Hee, (2012) “Asymmetry Of Mobile Termination Rates And The Waterbed Effect”, 23rd European Regional Conference of the International Telecommunication Society, Vienna, Austria, 1-4 July 2012.

Lee, Robin, (2011) "Dynamic Demand Estimation in Platform and Two-Sided Markets: TheWelfare Cost of Software Incompatibility", Working Paper, Stern School of Business, New York University.

Lyons, Sean. (2006) , “Measuring The Benefits Of Mobile Number Portability”. Working Paper, Department of Economics, Trinity College, Dublin.

McCloughan, Pat and Lyons, Sean, (2006) “Accounting For ARPU: New Evidence From International Panel Data” ,Telecommunications Policy 30(10-11):521-532.
Pesaran, Hasmen, Ullah, Aman and Yamagata, Takashi, (2008) “A Bias-Adjusted LM Test Of Error Cross-Section Independence” , The Econometrics Journal (11): 105-127.
Pesaran, Hasmen, (2004) “General Diagnostic Tests For Cross Section Dependence in Panels” , Working Paper, University of Cambridge, CWPE 0435.
Pesaran, Hasmen, (2006) “Estimation And Inference in Large Heterogenous Panels With Multifactor Error Structure” , Econometrica, 74: 967-1012.
Pesaran, Hasmen, (2007) “A Simple Panel Unit Root Test In The Presence Of Cross-Section Dependence”, Journal of Applied Econometrics 22(2): 265-312.
Pesaran, Hasmen and Yamagata, Takashi, (2008) “Testing Slope Homogeneity in Large Panels” , Journal of Econometrics 142(1): 50-93.
Rochet, Jean-Charles and Jean, Tirole, (2003) "Platform Competition in Two-Sided Markets", Journal of the European Economic Association 1(4): 990-1029.
Rochet, Jean-Charles and Jean, Tirole, (2006) "Two-Sided Markets: A Progress Report". RAND Journal of Economics 37(3): 645-667.
Rysman, Marc, (2009) "The Economics Of Two-Sided Markets", Journal of Economic Perspectives 23(3): 125-143.
Schiff, Aaron, (2008) “The ‘Waterbed’ Effect And Price Regulation” , Review of Network Economics 7(3): 392-414.
Shew, William, (1994) “Regulation, Competition And Prices in Cellular Telephony” , Working Paper, The American Enterprise Institute for Public Policy Research. No: 4329.
Song, Minjae, (2011) "Estimating Platform Market Power İn Two-Sided Markets With An Application To Magazine Advertising", Song, Minjae, Estimating Platform Market Power in Two-Sided Markets with an Application to Magazine Advertising (September 30, 2013). Simon School Working Paper No. FR 11-22. Available at SSRN: https://ssrn.com/abstract=1908621 or http://dx.doi.org/10.2139/ssrn.1908621.
OECD. (2009) “TwoSided Markets”, DAF/COMP (2009) 20, https://www.oecd.org/daf/competition/44445730.pdf
Valletti, Tommaso, (2006) “Mobile Call Termination: a Tale of Two-Sided Markets” , Antitrust and Regulation in the EU and US, Chapter 7, Edward Elgar Publishing.
Valverde, Carbo, Chakravorti, Sujit and Francisco, Fernandez, (2009) "Regulating Two-Sided Markets: An Empirical Investigation", Federal Reserve Bank of Chicago.
Westerlund, Joakim, (2008) “Panel Cointegration Tests Of The Fisher Effect” , Journal of Applied Econometrics 23(2): 193-223.
Weyl, Glen, (2010) "A Price Theory Of Multi-Sided Platforms", American Economic Review 100(4): 1642-1672.
Wright, Julian, (2004) "One-Sided Logic in Two-Sided Markets". Review of Network Economics 3(1): 42-63.