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Analyzing the Impacts of Privatization, Liberalization and Regulations on the Telecommunication Sector: An Emprical Study for OECD Countries

Fazıl Gökgöz[1] and Ahmet Zafer Gülşen[2]

Abstract

Telecommunication industry has gained a great deal of importance both for developed and developing countries in the global economy. Telecommunication services, which are necessary infrastructure investment for countries to develop economically and to keep their growth, occupy a more important position in rapid changing technology and in the globalizing economy of our day. The goal of this study is to analyze the impacts of the privatization, liberalization and regulations on the telecommunication sector on OECD countries have been researched in accordance with the literature through the Fixed Effects Model, Random Effects Model and Hausman–Taylor Model among the panel data analysis methods. In order to analyze the economic development variation, OECD countries have been divided into two groups empirical studies. According to results of the research, it is concluded that the reforms for the telecommunication sector have different impacts for the countries in different group of income. Consequently, it has found out that aforementioned mathematical methods could have significant results in analyzing the economical impacts on the telecommunication sector for OECD countries.

JEL classification numbers: L33, L96, G18, C23
Keywords: Privatization, Liberalization, Regulation, Telecommunication, OECD, panel data analysis

[1]Assoc. Prof. Dr. at Department of Management, Faculty of Political Sciences, Ankara University, Ankara, Turkey.
[2]Ministry of Economy, Ankara, Turkey.

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1 Introduction

The rapid alteration and dynamism in the telecommunication sector, in which the technological changes are peak, diversified the services provided by the sector and has made it necessary that the services are presented in an integrated way in the global level. Today, telecommunication services consist of not only the post, telegraph and telephone falling into classical service group, they also have become a sector where many services like e-mail, e-commerce, online banking that is offered through internet, also the services like mobile, car phone, broadband interactive and satellite are given.

On the other hand, the telecommunication sector has become one of the sectors which have the highest effect of speeding up the economic development. That the countries on the course for integration and progression have opened to foreign countries increased the significance of telecom sector. Besides, infrastructure of modern telecom has become a prerequisite for growth projects to be put into practice. Additionally, the role of communicational technologies in production process has increased with the convergence of the technologies of telecom and computer.

Different from other sectors, any progress occurred in the telecom sector affects also other sectors positively. All the sectors in the integrated world economy have become more dependent on the good communicational information services. It also provides support for both presentation and improvement of the services not only in the real sector, but also in the sectors such as health and education.

Right along with the increasing significance of the telecom sector, it is a field where the state interference is necessary based on the economic, social and political reasons arising from the features of the sector. This interference occurs in the ways that the state offers the service directly, and the state regulates and controls the service offered by the private sector. However, for the reason that the demand for the services offered by the state could not be met and the public sector could not adapt themselves to the improvements in technology, privatization practices became widespread in the early 80's. Beginning in the 80's and becoming widespread and an international phenomenon in the 90's in the world, privatization has also become the tool for the reconstruction in the telecommunication sector. On the other hand, achievement of the privatization is dependent on the creating of a competitive private sector, instead of public monopoly. In this regard, it is necessary to adopt the competitive practices and to establish a level playing field in the sector.

In many countries, an array of reforms has been carried out for the sector to operate effectively because of the inherent features of telecom sector. These reforms are classified as privatization, liberalization and regulation. The effect of aforesaid reforms on the performance of the sector has been examined for different regions and groups of countries so far and the analyses containing OECD countries have not been made, yet. As it is known, 34 countries occupying an important position in the world economy are the members of OECD. According to the World Bank Development Indicators, world gross domestic products of the stated countries are 45.9 trillion USA dollars in total as of the end of 2012 and 10% of the total gross domestic product produced in the entire world, amounted 471.929 trillion US dollars, is produced by these countries.

On the other side, incomes, capital expenditures, the employment they created and the number of subscribers of the big telecom operators that are in business in the OECD region are in substantial amounts. As of the end of 2011, extents of the 50 telecom operators chosen among 22 OECD member countries are given in the Appendix 1.

It can be seen in the Appendix 1, as of the end of 2011, that the total revenue of important

telecom operators in the OECD region is about 1.3 trillion US dollars and the total revenue of these 50 firms in 2011 is bigger than the GDPs of 25 countries in the OECD region in 2011. Besides, income of the firms is 78.6 billion US dollars and the employment they created is over 2.7 million people. Additionally, aforementioned operators offer mobile service for more than 2.5 billion people. In this big area, where one-tenth of the world economy is produced, and as of end of 2011, %35 of the 7-billion world population is offered service, reforms for the telecom sector is worth analyzing.

The remainder of the paper is organized as follows. The following section overviews the main literature analyzing impacts of the reforms for the telecom sector. Section 3 includes hypothesis. Section 4 presents information related to the methodology. Section 5 describes the data and the model. Section 6 presents the analysis and the findings. Finally, Section 7 concludes.

2 Literature Review

In Developing Countries (DC), two kinds of analysis are generally seen in the literature about reforms: Case studies and empirical studies comparing the performances between countries or companies before and after the reforms. For the reforms began in Latin American countries respectively earlier, majority of the proofs belong to these groups of countries. Generally, it is seen that studies reveal the positive impacts of the reforms.

In his study where he analyzed the impacts of privatization on the basis of case studies, Wellenius (1992) concluded that privatizations are enhancing the financial performances of the companies and they are encouraging the domestic funds and international investments.

Galal et al. (1992) dealt with the privatizations of British Telecom *(BT)*, Mexico Telephone Management *(Telefonos de Mexico, TELMEX)* and Chile Telecom Company *(CTC)* with regard to regulation and it is determined that the privatization and regulation experiences of each of the three companies caused their operating and financial performances to enhance observably.

Having researched the relative roles of the privatization, liberalization and regulations in determining the increase of the performance in the telecommunication sector, Parker (1994) established that tariffs decreased by %10 in real terms with the privatization in 1984; and quality of the service and profitability increased. On the other hand, with the aforementioned study, it was concluded that the employment decreased by one-third in ten years following the privatization.

In his study where he researched the wealth effect of privatizations, Tandon (1995) concluded that total factor productivity increased by %15 at the end of three years following the privatization of the settled telecom operator and the number of lines in service increased rapidly. Moreover, due to the number portability and competition were simultaneous, it was stated that it was almost impossible to determine the net benefit.

In their studies where they analyzed the impacts of competition in Asia and Latin America, Petrazzini and Clark (1996) accepted the existence of the mobile telecom operators as the proof of the competition and compared competitive and non-competitive markets. They established that competitive markets have more input rates related to mobile services rather than non-competitive markets.

Boles de Boer and Evans (1996) deduced that after the privatization of New Zealand

Telecom in 1990, there were apparent decreases in the tariffs of telephone services because of the major and rapid increases of productivity and quality. Besides, Ramamurti (1996) researched four telecom privatizations in Latin America and concluded that all of them were successful both politically and economically.

19 Latin America countries were studied by Gutierrez and Berg (2000) for the fixed-line extension. They researched the impacts of the investments in the telecom sector, regulations as dummy variable, income per capita, population per kilometer, exportation, the number of mobile telephone subscribers on the number of the fixed-line of economic freedom index and democracy index per 100 people. As a result of the study, it is determined that the existence of the institutional regulation framework and the political factors have a positive effect on the line extension. With reference to the economic freedom index, it is concluded that privatization works have also positive impact on the line extension; the existence of independent regulatory authorities and sectoral policies increase the sectoral efficiency.

Li et al.(2001) researched the impacts of privatization, competition and existence of an independent regulatory authority on the fixed and mobile capacity, profitability and local calling fees. It is analyzed by using 167 countries' telecommunication data between the years 1981-1998 for privatizations; 50 countries' telecommunication data between the years 1990-1998 for competition policies through the panel data analysis method. As a result of the study, the positive relationship between alone the privatization and the fixed-line penetration could not be confirmed. On the other hand, when privatization and competition policies are analyzed together, it is determined that they have a positive impact on trunk line concentration speed. However, it is understood that existence of an independent regulatory authority itself has a negative impact on the trunk line concentration.

Wallsten (2001) econometrically analyzed the impacts of reforms practiced for telecommunication sector in DC's. He researched the impacts of competition, privatization and regulation framework, which are represented with the existence of the mobile operator that is not operated by the settled operator in the country, on the sector with panel data analysis method. The data set which was compiled from the statistics published by the International Telecommunications Union (ITU) of 30 countries located between the Africa and Latin America countries between the years 1984-1997 was used. Due to the different features of the countries, fixed effects model was used to control the non-observable country specific factors. He researched the impacts of privatization, competition and regulation reforms on the number of trunk lines per capita, the number of payphone subscribers, network interface capacity per capita and the number of workers per trunk line. Competition variable in the model, where the aforementioned reforms' impacts were researched, was represented with the number of mobile operators that the settled operator had not. The variables of privatization and regulation were included as dummy variables in the analysis. Value 1 was given to this variable for the year privatization was practiced and after that year; value 0 was given to the variable for other years. Value 1 was given to regulation dummy variable for the year a regulatory authority was established and after that year; value 0 was given to the variable for other years. Besides, income per capita, population, the rate of the population in cities to the total population, dummy variable for whether the telecom reform legislation is valid or not, a dummy variable for whether there is an active project of the World Bank *(WB)* in the current year, if there is, the share of net WB help in the Gross National Product *(GNP)*, the share of exportation in the GNP and a variable measuring the eminent risk were used

as control variables in the model. These macroeconomic and demographic data used as control variable were taken from WB Statistical Information and Management Analysis database. Control variable related to the eminent risk was taken from International Country Risk Guide *(ICRG)*. Risk variable has a value between 1 and 10 and the value 10 represents the lowest eminent risk. According to Wallsten (2001), in case of privatization of a natural monopoly alone without making any regulation theoretically, expected enhancements in the telecom sector will not occur. That's why it is put forward that there is a necessity for a careful regulation framework to increase the performance of a monopoly. In this respect, he developed a second model by making regulation dummy variable interact with privatization and competition variables separately to study the further impacts of the regulation. In this second model, he evaluated the impacts of privatization-regulation and liberalization-regulation together.

Wallsten (2002) researched the impacts of telecom firms' creating an institutional framework to encourage the competition before privatization. He tested two hypotheses with the data collected between the years 1985 and 1999 from 197 countries. The first of the hypotheses argues that existence of a regulatory authority specific to the sector before the privatization increases the performance of the sector. Other one argues that existence of the regulatory authority has a booster impact on the price that the investors accept to pay to the firm which is privatized. So as to test these hypotheses, the number of fixed-phone lines, the number of lines per capita, the amount of the investment and the number of the mobile telephone users in the country were used as variable. Privatization, existence of the regulatory authority and independency of the regulatory authority were used as dummy variable. With this study, it has been determined that before the privatization of the settled telecom operator, sectoral investments, the penetration rates of fixed and mobile phones increased in the countries which established independent regulatory authority more than the countries which did not establish such an authority. Besides, it was seen that investors accepted to pay a higher payment for the telecom companies, which would be privatized, in countries which established the regulatory authority before the privatization.

Another study analyzing the performance of the telecommunication sector by using the Regulatory Framework Index was executed by Gutierrez in 2003. Gutierrez (2003) accepted the reforms for the telecom sector as privatization, liberalization and regulatory developments. In the study which was carried out with the panel data analysis method by using the data of 22 countries located between Latin America and the Caribbean countries between the years 1980 and 1997, network extensity indicator *(the number of trunk lines per 100 people)* and efficiency indicator *(the number of trunk lines per worker)* were used as two dependent variables. The variables of privatization, liberalization and regulation were determined as explanatory variables and included as dummy variable in the analysis. As a consequence of the study, it is established that telecom reforms have a positive impact on the number of the trunk lines per 100 people. Additionally, it is put forward that for the countries in them sample under the rules of privatization, liberalization and regulation, sectoral efficiency has increased.

Fink et al. (2003) analyzed the impact of the political reforms *(privatization - liberalization - regulation)* for the basic telecommunication services on the sectoral performance, by using the panel data of 86 countries located between the Africa, Asia, Middle East, Latin America and Caribbean countries for the period containing the years 1985-1999. As a result of the study, it is concluded that both privatization and liberalization have considerably increased the performance of the sector. When an

extensive reform program that includes both competition with privatization, and also the establishment of an independent regulatory authority is compared to the years when partial reforms were practiced or reforms were not practiced, it is seen that the greatest gains have been acquired. In case privatization, liberalization and regulation reforms are practiced together, the number of the trunk lines increases by %8, efficiency increases by %21 to a higher level, when compared to cases of partial reform or none-reform. Out of the study, it is also concluded that the row of the reforms is also important. If liberalization is practiced after privatization, trunk line penetration is relatively less than they are practiced simultaneously. Furthermore, it is determined that specific factors such as technological improvements have a strong effect on the performance. It is stated that for the aforementioned analysis process, an increase by %5 in teledensity and an increase by %9 in efficiency were derived from the technological improvements.

The empirical consequences derived from the study are considerably appropriate to the traditional way of thinking. Only privatization significantly increases the payphone penetration, however does not have any other benefits; it also causes a decrease in the trunk line penetration and network interface capacity. When regulation framework and privatization are practiced together, on the other hand, payphone penetration, interface capacity, the number of workers per trunk line and labor productivity increase, local calling fees decrease. In this respect, it is stated that privatization that is not supported with regulation is more costly for the consumers. To sum up, it is determined that while only competition increases the trunk line and payphone penetration and interface capacity per capita, it decreases local calling fees. As a result, privatization alone could not provide the expected benefits and it decreases the trunk line penetration. Privatization supported by the regulation framework increases the trunk line and payphone penetration and interface capacity; decreases the local calling fees.

With respect to the results, it can be said that reform efforts should be concentrated on the right areas. It is perceived that while settled telecom operator is being privatized, competition should be encouraged and a regulatory framework has to be established. Empirical studies analyzed above demonstrate that privatizations are generally not enough by themselves and they have to be practiced with liberalization and regulation reforms. It is also understood that productivity, employment, investment, fees, penetration and positive developments in the quality indicators are not dependent only on privatization; competition has to be provided in the sector, a regulatory framework has to be established and impacts of these should be analyzed together.

Li and Xu (2004) researched the impacts of privatization and competition on the telecommunication sector with the panel data analysis method by using the data from 1990 to 2001. In the study, in case that there are private investors' share in the country's telecom sector, "1" is referred to the privatization dummy variable; in the contrary case, it is referred to "0". Similarly, whether the method of public offering is used or not in privatization and the public share rates in the settled operator to analyze the property changing in a better way is also determined with the dummy variable. Competition variables in the study are determined with the number of fixed and mobile telephone operators in the country. Among the variables used to measure the performance of the sector are the level of employment, labor productivity *(aggregate output/employment)*, capital expenditure per capita, fixed-line penetration *(density)*, mobile line penetration and total factor productivity. With this study, writers analyzed the extended indicators for 162 countries in the telecom sector and determined that privatization and competition has a performance-developer impact. In parallel with the thought that the privatized firms are

more resistant to the political oppressions for increasing the employment, they concluded that privatization decreased the employment in the telecom sector. They also concluded that partial privatizations were not successful enough; and the privatizations, in which all public properties were removed, enhanced the labor and capital distribution and increased the labor and total factor productivity considerably and also raised the penetration rates.
Additionally, they determined that the property in the sector were transferred from public to private investors rapidly, the amount of production increased and the decrease in the employment was met with the increase of labor productivity. They found that half of the increase in the amount of the production resulted from total factor efficiency that developed out of privatization and competition. Although success could not be fulfilled exactly in the privatization, they concluded that privatization increased the productivity. However, they put forward that increases in productivity were much more in cases liberalization was able to be supplied. They determined that the competitive environment created by privatization and liberalization increased the productivity and the level of output, raised penetration rates of both the mobile and the fixed telephones and that privatization and competition completed each other. It was also stated that production increase was achieved with less labor and this was the indicator of increase in the labor productivity. They concluded that %40 of the increase in the labor productivity resulted from privatization and competition. As a consequence, they put forward as an ideal political suggestion that the process of privatization should be supported with the competition policies.

3 Hypothesis

It is seen that when the literature given above is considered, there is an impact of privatization, liberalization and regulation reforms on the performance of the sector. In the empirical studies for the research of the performance of the telecom sector, it is commonly seen that the panel data analysis method is used regarding the certain groups of country and a certain period of time. On the other side, the impacts of the reforms on the performance of the sector are mentioned separately in many studies; however, there are no studies which analyze the impacts of these reforms together. In this respect, when the impacts of privatization, liberalization and regulation reforms of the OECD member countries between the years 1992-2010 separately and together, such as "privatization-liberalization", "privatization-regulation", "liberalization-regulation" and "privatization-liberalization-regulation", on the total number of subscribers, total employment, call fees and labor productivity are analyzed. In this framework, following hypotheses are going to be questioned through the panel data analysis methods related to the impacts of the reforms practiced in the OECD countries in the time period 1992-2010 on the number of subscribers, labor productivity, fees and employment factors.
H_1: Only privatization has an increasing impact on the number of subscribers and the labor productivity in the telecom sector and a decreasing impact on the fees and the sectoral employment.
H_2: Only liberalization and only regulation have an increasing impact on the number of subscribers, the sectoral employment and the labor productivity in the telecom sector and a decreasing impact on the fees.
H_3: Privatization and liberalization reforms together have an increasing impact on the number of subscribers and the labor efficiency in the telecom sector and a decreasing

impact on the fees and the sectoral employment.
H_4: Privatization and regulation reforms together have an increasing impact on the number of subscribers and the labor efficiency in the telecom sector and a decreasing impact on the fees and the sectoral employment.
H_5: Liberalization and regulation reforms together have an increasing impact on the number of subscribers, the sectoral employment and the labor productivity in the telecom sector and a decreasing impact on the fees.
H_6: Privatization, liberalization and regulation reforms together have an increasing impact on the number of subscribers, the sectoral employment and the labor productivity in the telecom sector and a decreasing impact on the fees.

4 The Methodology

4.1 Panel Data Analysis

In panel data analysis, which is a method of estimating the economic relationships by using the cross section series that have time dimension, a data set which has both time and cross section dimensions is created by gathering the time sections and the cross sections. Panel data analysis is stated as the following number (1) equation:

$$Y_{it} = \beta_{1it} + \beta_{2it} X_{2it} + ... + \beta_{kit} X_{kit} + \varepsilon_{it} \qquad (1)$$

$$i = 1,..., N$$
$$t = 1,..., T$$

Here N shows units, *t* shows time. When *Y* variable is dependent variable which takes different values from unit to unit and from a time period to sequential time period, it is expressed as two sub-indices such as *i* for the cross section dimension and *t* for the time period. This general model allows stable coefficient and regression parameters to leave in every time period for every variable.
Containing data of the time series and the horizontal cross section together, panel data analysis has various advantages compared to the analysis methods that contain only time series or horizontal cross section data. These superiorities are like the following (Gujarati, 2004: 637-638; Baltagi, 2008: 3-6):

- The number of observations is more in number because panel data method combines the cross section and time series observations.
- There are less multiple correlation problems between panel data variables.
- In further levels, it contains degree of freedom, less linearity and sample variability.
- It is better at revealing the dynamic relationships.
- It allows econometric analysis to be made in cases of short time series and/or inadequate cross section observations.

Beside the advantages it has, panel data analysis has also some disadvantages. For instance, coefficients take different values in different time periods in the model expressed with number (1) equation above. Then, estimated number of parameters exceeds the number of observations and the new model cannot be estimated. Due to this disadvantage, the features of the error terms and different models that have different

assumptions about the variability of the coefficients are used in the studies done with the panel data analysis. These models are "Random Effect Model" and "Fixed Effect Model". Before mentioning about the models briefly, it is better to state that in both models, it is assumed that ε_{it} error terms are distributed in all time periods and for all units independently and in the way like $N(0, \sigma_{\varepsilon}^2)$.

4.1.1 Fixed Effects Model

Fixed effect model composes a different fixed value for every horizontal cross section unit. In this model, it is assumed with β that slope coefficients do not change, but stable coefficients show an alteration only between the cross section data or only between the time data or in both data. General formulation of the Fixed Effects Model is shown like the following number (2) equation (Gujarati, 2004: 642):

$$Y_{it} = \alpha_i + \beta_{1i} X_{1it} + \beta_{2i} X_{2it} + ... + \beta_{Mi} X_{Mit} + \varepsilon_{it} \quad (2)$$

α_i is a stable coefficient which alters by units but does not alter during the time. This coefficient also represents the average belonging to the relevant unit and can be written also as $\acute{a}_i = \alpha + y_i$. As being like this $\sum_{i=0}^{N} y_i = 0$, the expression of y_i shows the deviation from the general average. $\varepsilon_{it} \approx N(0, \alpha_{\varepsilon}^2)$ shows the random variable. There are different strategies to estimate the fixed effect model. Among these methods, the most common one is the least squares dummy variable model. This model is expressed as the following:

$$Y_{it} = \alpha_1 + \alpha_2 D_{2i} + ... + \alpha_N D_{Ni} + \beta_{1i} X_{1it} + \beta_{2i} X_{2it} + ... + \beta_{Mi} X_{Mit} + \varepsilon_{it} \quad (3)$$

In the equation, the statement of *Dji* takes the value 1 for *j*-th unit, and the value 0 for others. For example, while the stable value is α_1 for the first unit, the value of the stable coefficient is ($\alpha_1 + \alpha_2$) for the second unit. α_2 is the parameter which makes the difference between the first and the second units. Others are expressed similarly.
Although fixed effects model is used commonly, being too many horizontal cross sections dependent on the use of the dummy variable causes the loss of degree of freedom. The reason why fixed effect model is used is the failure of including the relevant explanatory variables in describing the model into the model as time passes by and the coverage of this ignorance by the dummy variables being included into the model. Because the dummy variables do not give the precise information about the right model, Random Effect Model, or in other words, error component model is suggested (Baltagi, 2008: 17-21).

4.1.2 Random Effects Model

General representation of the random effect model is like the number (2) equation above. However, here α_i is assumed to be a random variable which has $\alpha_1$average value. In other words, if it is the value of stable coefficient of a variable, it is expressed like $\alpha_i = \alpha_1 + \mu_i$, *i = 1, 2, ..., N*. In this equation, μ_i is the random error term with zero mean and σ_{μ}^2

variance. Besides, if the expression of $\alpha_i = \alpha_1 + \mu_i$ is put in its place in the equation;

$$Y_{it} = \alpha_1 + \beta_{1i} X_{1it} + \beta_{2i} X_{2it} + ... + \beta_{Mi} X_{Mit} + \mu_i + \varepsilon_{it} \quad (4)$$

$$Y_{it} = \alpha_1 + \beta_{1i} X_{1it} + \beta_{2i} X_{2it} + ... + \beta_{Mi} X_{Mit} + w_{it} \quad (5)$$

It is written as above and w_{it} is a combined error term composed of two components. In other words, w_{it} equals to the total of the relevant unit-specific error term μ_i and the error term ε_{it}, which is consisted of the combination of the time series and the cross section.

In the model, it is assumed that individual-specific error terms do not have correlations with each other and do not have autocorrelations also with the data of the horizontal cross sections and the time series. If it is considered that there is no correlation between individual-specific error term and independent variables, it will be more appropriate to practice this model.

The active estimation method used for estimating the random effects model is Generalized Least Squares (GLS) method. If the number of cross section unit in the panel data is much and the time period is short, random effects model will have more effective estimations than fixed effects model. The reason for this is that the number of parameters to be estimated by the fixed effects model for the horizontal cross section units. From this aspect, it is very important which model is used when the number of the horizontal cross section units is much because of the validity of the analysis. Besides, the more the number of the time periods, the closer the consequences of random and fixed effects models are. Additionally, if the cross section units are taken randomly from the sample universe, random effects model is evaluated as more appropriate model (Gujarati, 2004: 650-651; Gökbulut, 2009: 153):

The disadvantages of fixed effects model compose the advantages of random effects model. When the sample growth increases in random effects model, the number of the parameters remain constant. Model allows predictors which can use the intragroup and the intergroup variance to be created. Furthermore, model also has superiority against fixed effects model in estimating the variables that do not alter in time (Hsiao, 2003: 41).

4.1.3 Hausman - Taylor Model

Between the fixed effects and random effects models, the question of which one to choose is still a up-to-date discussion (Baltagi et al., 2003: 361): Mundalk (1978) discussed that the random effects model assumes *all* the variables are exogeneity and they have random individual effects. On the contrary, fixed effects model enables the endogeneity of *all* variables and the individual effects. About the correlation choice between the *all (or none)* and individual effects, Hausman and Taylor (1981) suggested a new model including the some estimators being associated with individual effects. Having advantages against fixed and random effects model and being used commonly in recent years, Hausman - Taylor Model is a model which takes into consideration the endogeneity among the independent variables, and also the interaction between dependent and independent variable.

The estimator acquired with the model is called Hausman-Taylor *(HT)* estimator and HT is exactly based on a tool variable estimator used for exogen variables. More specifically, individual averages of the exactly exogen variables are used for helping the variables that have the correlation with the individual effects and do not alter in time. Choosing the exactly exogen variables is a testable hypothesis. In fact, it is Hausman test based on the

contrast between fixed effects and HT estimators (Baltagi et al., 2003: 361-362).
The basic assumption of this model is that one-down subset of the explanatory variables is correlated with the unit *(random)* effects, but not correlated with the error element (μ_{it}). So, explanatory variables consist of both endogen and also exogen variables. Besides, explanatory variables may consist of both the variables that alter according to time and also the variables that do not alter according to the time. These four groups of variable are included in the model separately and estimations are done like this (Tatoğlu, 2012: 147).
For some non-observable effects can be associated with some other explanatory variables, Hausman and Taylor (1981: 1379 - 1382) developed the following model:

$$y_{it} = X_{it}\beta + Z_i\eta + \alpha_i + \mu_{it} \tag{6}$$

Here, $i = 1, 2, \ldots, N$ and $t = 1, 2, \ldots,$ *is* T. Z_i is the individual variables that do not change in time. α_i has identically and independently distributed features (0, σ_α^2) and μ_{it} has identically and independently distributed features (0, σ_μ^2) and they both are independent from each other. Hausman and Taylor (1981: 1379) divided the variables of $X = [X_1, X_2]$ and $Z = [Z_1, Z_2]$ into two sets of variables such as: X_1 is (n x k_1) and X_2 is (n x k_2); and Z_1 is (n x g_1), Z_2 is (n x g_2) and $n = NT$. While X_2 and Z_2, are endogen variables because they have correlation with α_i and do not have with μ_{it}; X_1 and Z_1 are accepted as exogen and it is assumed that they do not have correlation with α_i and μ_{it}.
If the number (6) model above is estimated with the random effects assumption because X_2 and Z_2 have correlation with the unit effect, the parameters in the model are incoherent because of the negligence of an important assumption of random effects model. On the other hand, if it is estimated with fixed effects assumption, α_i falls from the model as a result of an intragroup transformation as well as Z_1 and Z_2 and that's why β and η parameters cannot be estimated. HT estimator has been produced to solve this problem.
Hausman and Taylor (1981: 1386) suggest a tool variable estimator, which is acquired by multiplying the number (6) equation above by $\Omega^{-1/2}$. Ω error component is the variance covariance term of ($\alpha_i + \mu_{it}$) and the tool variance carries out the two stage least squares (2sls) by using [Q, X_1, Z_1]. As $\bar{y}_t$ being the average, Q typically is a transformation matrix that have ($\hat{y}_{it} = y_{it} - \bar{y}_t$) and $\hat{y} = Qy$. This will lead to a result that equals to two stage least squares with [$\hat{X}, \overline{X}_1, Z_1$]. If the model is defined by endogen variables Z_2 (i.e. $k_1 \geq g_2$) that do not alter in time at least as much as exogen variables X_1 that alter in time, then HT estimator will be more efficient than fixed effects. If the model is defined for $k_1 < g_2$, η cannot be estimated and the HT estimator of β will give the same result as the fixed effects model.

5 Data and Model

In our study, reforms for the telecom sector are accepted as privatization, liberalization and regulation. In this framework, as privatization variable, for the year when the first privatization of the incumbent operator in the telecom sector is practiced and the years after that, dummy variable value is assigned *"1"* and for the former years it is *"0"*. Liberalization is measured with the existence of the mobile telephone services in addition to the fixed telecommunication services. In other words, for the year when a new operator start to offer service in the mobile services area in addition to an incumbent operator offering fixed telephone service and the years after that, dummy variable is accepted as *"1"* and for the former years it is "0". Similarly, for the year when a regulatory independent authority is established and the years after that, dummy variable is *"1"* and for the former years, it is *"0"*. While determining the values of these three dummy variables, *"World Telecommunication Regulation Database"* published by ITU (2010) was used in the empirical studies.

In order to evaluate the impacts of the aforementioned reforms separately and together, all the necessary data for our study about the telecom sector for OECD countries between the years 1992 – 2010 were compiled from the statistics annuals published by ITU (ITU, 2003; ITU, 2011). By using the annuals, total number of the mobile and fixed telephone subscribers, three-minute call fee as a price index denominated in US dollar, total amount of employment in the sector, labor productivity calculated by the rate of the total income to the total employment, total annual income and investment amount; GDP per capita, population density and surface area of OECD countries were compiled by using the database of the WB (2012).

The following Table 1 presents the list of variables used in the study and data sources.

Table 1: Description of the variables

Variable Name	Description	Data Source
Privatization *(PRV)*	For the year when the first privatization of the incumbent operator in the telecom sector is practiced and the years after that, dummy variable value is assigned *"1"* and for the former years it is *"0"*.	ITU
Liberalization *(LIB)*	For the year when a new operator start to offer service in the mobile services area in addition to an incumbent operator offering fixed telephone service and the years after that, dummy variable is accepted as *"1"*and for the former years it is *"0"*.	ITU
Regulation *(REG)*	For the year when a regulatory independent authority is established and the years after that, dummy variable is *"1"* and for the former years, it is *"0"*.	ITU
Total Subscribers (TS)	The number of users of mobile and fixed-line	ITU
Price *(P)*	Three-minute call fee denominated in US dollar in the peak time	ITU
Total Employment *(TE)*	Total number of employees in the sector	ITU
Labor Productivity *(LP)*	The rate of total sectoral income to the total employment	ITU
Total Revenue *(TR)*	Total amount of sectoral revenue *(million US dollar)*	ITU
Total Investment *(TI)*	Total amount of sectoral investment *(million US dollar)*	ITU
GDP Per Capita	Countries' gross domestic product per capita with current prices *(US dollar)*	WB
Population Density *(PD)*	Population per km^2	WB
Surface Area *(SA)*	Surface area of the countries by km^2	WB

Among these variables, TS is dependent variable in the following Model-1, while it is independent variable in Model-3 and Model-4. TE, P and LP variables are respectively dependent variables in Model-2, Model-3 and Model-4, while P variable is also independent variable in Model-1. TR and TI variables are both used as independent variables in Model-3 and TI variable is also independent variable in Model-2, again. Along with these, GDP per capita, PD and SA variables are used as independent variables in all the models.

Under the study, OECD countries, having 34 members as of end of 2010, have been analyzed. OECD countries are divided into two groups to analyze the impacts of the economic development variations of the OECD countries. In World Development Indicators *(WDI)* published by the WB, OECD countries are divided into two groups as high income countries *(30 countries)* and other countries *(4 countries)*. According to this separation, another classification has been made in our study considering the difficulties of deducing results from the panel data analysis. According to the purchasing power parity in 2010 acquired from WDI, considering the GDP per capita, the average of the OECD countries is determined as 36.883 US dollars and the countries above the average have been evaluated in the 1st Group and the countries below the average have been evaluated in the 2nd Group. Details related to this grouping are given in the following Table 2.

Table 2: OECD Country Classification Used in the Analysis

1st Group OECD Countries	GDP Per Capita (2010, US Dollar)	2nd Group OECD Countries	GDP Per Capita (2010, US Dollar)
Luxemburg	105,194	England	36,343
Norway	85,388	Italy	34,075
Switzerland	67,457	New Zealand	32,407
Denmark	56,244	Spain	30,548
Australia	50,747	Israel	28,506
Sweden	48,896	Greece	26,606
USA	47,153	Slovenia	22,893
Netherlands	46,903	Portugal	21,486
Canada	46,212	Korea	20,756
Ireland	46,170	Czech Republic	18,254
Austria	45,181	Slovak Republic	16,071
Finland	44,377	Estonia	14,340
Belgium	43,077	Hungary	12,863
Japan	42,830	Chile	12,431
Germany	40,115	Poland	12,294
Iceland	39,541	Turkey	10,094
France	39,448	Mexico	9,132

Source: WDI, 2010.

In the following Table 3, there are summary statistics related to the variables of the 1st Group OECD countries between the years 1992 – 2010 in our models.

Table 3: Summary Statistics of the 1st Group OECD Countries (1992 –2010)

	Total Subscribers	Calling Fee	Total Employment	Labor Productivity	Total Revenue	Total Investment	GDP Per Capita	Population Density
Average	42,462,043	0.2083	121.655	%21.51	27.932	6.032	36,623	126
Std. Deviation	78,778,805	0,2330	245.465	0.1046	67.668	10.941	15,446	138.75
Mode	*N.A.*	0,1852	97.300	*N.A.*	2.857	23.000	*N.A.*	*N.A.*
Median	11,142,000	0,1542	23,869	%19.26	5,170	1,603	34,106	96
Maximum	430,071,000	1,9500	1,186,000	%66.30	391,445	80,651	118,219	493
Minimum	155,282	0,0395	800	%7.24	85	25	14,211	2.28
Number of observations	323	323	323	323	323	323	323	323

Source: Author's calculations.

As can be seen from the Table 3 above, there are over 42 million subscribers in total in the 1st Group OECD countries and the three-minute calling fee in the peak time is 0.20 US dollars on average. Additionally, it can be seen that total employment is about 121.000 and the labor productivity is at the rate of 21.5%. Sectoral average total revenue and total investment are respectively 27.9 million and 6 million US dollar. Finally, GDP per capita of the 1st Group OECD countries is over 36.000 US dollars and in these countries, there are 126 per square kilometer. Similarly, in the following Table 4, there are summary statistics about 2nd Group OECD countries as of the same period.

Table 4: Summary Statistics of the 2nd Group OECD Countries (1992 –2010)

	Total Subscribers	Calling Fee	Total Employment	Labor Productivity	Total Revenue	Total Investment	GDP Per Capita	Population Density
Average	24,325,869	0.1672	45,551	%17.93	9.210	2,269	13,657	134
Std. Deviation	29,404,454	0.3273	45,646	0.1301	12.050	2,979	8,986	113.33
Mode	3,033,000	0.1500	182,000	N.A.	N.A.	N.A.	N.A.	N.A.
Median	12,285,000	0.1101	23,352	%15.38	3,760	967	11,858	111
Maximum	114,508,000	2.8877	236,000	%91.27	63,738	16,348	46,230	503
Minimum	341,868	0.000061	2,172	%0.44	21	8,18	2,257	13.41
Number of observations	323	323	323	323	323	323	323	323

Source: Author's calculations.

It is seen in the Table 4 above that in 2nd Group OECD countries, there are 24.3 million subscribers in total on average and the three-minute calling fee in the peak time is 0.16 US dollars on average. It is also seen that total employment is about 45.000 people and the labor productivity is at the rate of 17.9%. Sectoral total revenue is 9.2 million US dollars on average, while average total investment is 2.2 million US dollars. GPD per capita of the 2nd Group OECD countries is 13.657 US dollars and in these countries, there are 134 people per square kilometer.

From the analysis of the studies researching the impacts of the reforms practiced in the telecom sector, it is inferred that the empirical method used in the studies of the aforementioned area is dominantly panel data analysis. In this framework, the impacts of the reform works in the OECD countries are going to be analyzed with the panel data

analysis in parallel with the literature.
The regressions shown in the following equations have been established to be estimated in the models that were tested with the aforementioned method.

Model – 1:

$$TS_{it} = \alpha_{it} + \beta_1 PR_{it} + \beta_2 LIB_{it} + \beta_3 REG_{it} + \beta_4 (PR_{it}.LIB_{it}) + \beta_5 (PR_{it}.REG_{it}) + \beta_6 D(LIB_{it}.REG_{it}) + \beta_7 (PR_{it}.LIB_{it}.REG_{it}) + \beta_8 GDP\ per\ capit + \beta_9 P_{it} + \beta_{10} PD_{it} + \beta_{11} SA_{it} + \varepsilon_{it}$$

Model – 2:

$$TE_{it} = \alpha_{it} + \beta_1 PR_{it} + \beta_2 LIB_{it} + \beta_3 REG_{it} + \beta_4 (PR_{it}.LIB_{it}) + \beta 5 (PR_{it}.REG_{it}) + \beta_6 D(LIB_{it}.REG_{it}) + \beta_7 (PR_{it}.LIB_{it}.REG_{it}) + \beta_8 GDP\ per\ capit + \beta_9 TI_i + \beta_{10} PD_{it} + \beta_{11} SA_{it} + \varepsilon_{it}$$

Model – 3:

$$P_{it} = \alpha_{it} + \beta_1 PR_{it} + \beta_2 LIB_{it} + \beta_3 REG_{it} + \beta_4 (PR_{it}.LIB_{it}) + \beta_5 (PR_{it}.REG_{it}) + \beta_6 D(LIB_{it}.REG_{it}) + \beta_7 (PR_{it}.LIB_{it}.REG_{it}) + \beta_8 GDP\ per\ capit + \beta_9 TI_i + \beta_{10} TR_{it} + \beta_{11} TS_{it} + \beta_{12} PD_{it} + \beta_{13} SA_{it} + \varepsilon_{it}$$

Model – 4:

$$LP_{it} = \alpha_{it} + \beta_1 PR_{it} + \beta_2 LIB_{it} + \beta_3 REG_{it} + \beta_4 (PR_{it}.LIB_{it}) + \beta_5 (PR_{it}.REG_{it}) + \beta_6 D(LIB_{it}.REG_{it}) + \beta_7 (PR_{it}.LIB_{it}.REG.it) + \beta_8 GDP\ per\ capit + \beta_9 TS_i + \beta_{10} PD_{it} + \beta_{11} SA_{it} + \varepsilon_{it}$$

6 Analysis and Findings

The impacts of the reforms practiced between the years 1992 – 2010 for the telecommunication sector in OECD countries on total number of subscribers (Model–1), total employment (Model–2), prices (Model–3) and labor productivity (Model–4) have been analyzed with the models expressed in the number (2), (5) and (6) equations above and these models are respectively fixed effects, random effects and Hausman-Taylor models. To remember, it was stated that OECD countries were divided into two groups to analyze the impacts of the economic development variations of the OECD countries. In this respect, these four different models have been analyzed with three different methods for the OECD countries classified in two separate groups. Furthermore, as stated before, the existence of privatization, liberalization and regulation reforms between the years 1992-2010 have been included in the models by defining the dummy variables. Results acquired from the Model–1 are in the Appendix 2.

When analyzed the results acquired from the impacts of the reforms for telecommunication sector on the total number of subscribers partaking in the Appendix 2, it is understood that both in fixed effects and random effects models, regulation and liberalization separately have a positive impact on the total number of subscribers in the 1st Group OECD countries. Moreover, it is seen that according to fixed effects model, only the regulation and liberalization separately by themselves have a positive impact; however, according to the random effects model, real GDP per capita, population density and surface area have also a positive impact on the total number of subscribers in addition to the regulation and liberalization separately by themselves. While the total number of subscribers in the 1st Group OECD countries increase by 17.9% and 15.8% according to the fixed effects and random effects model respectively at the level of 1% significance in case only the regulation is practiced, the total number of subscribers increase by 19.9% and 16.5% respectively in case only the liberalization is practiced. According to Hausman–Taylor model being applied for the 1st Group OECD countries, it is seen that *"privatization and regulation"* together with the real GDP per capita, calling fee and population density have a positive impact on the total number of subscribers.

According to the random effects model, increase by 1% in the real GDP per capita in the 1st Group OECD countries leads to increase by 0.15% of the total number of subscribers. On the other hand, increase by 1% in the population density increases the total number of the subscribers by 0.96%.

According to Hausman–Taylor model, total number of the subscribers increases by 9.9% in case *"privatization and regulation"* are practiced together. Furthermore, it is seen that increase by 1% in the income per capita and population density leads to the increase in total number of the subscribers respectively 0.19% and 0.98%. What is interesting is that increase by 1% in call fees, as of the analysis period in the 1st Group OECD countries, increases total number of the subscribers by 0.08%. Although the prices have been increased in the 1st Group OECD countries in the relevant time period, we can link this situation to the increase in demand for the telecommunication services when considered the technological improvements in these countries.

On the other side, in the 2nd Group, which is consisted of the countries that are below the average income of the OECD countries partaking in the Appendix 2, there are increases in total number of the subscribers by 24.3% , 22.2% and 26% according to fixed effects, random effects and Hausman-Taylor models respectively in case of the existence of only the liberalization. Moreover, total number of the subscribers decreases by 23% and 26.6% according to fixed effects and Hausman–Taylor models respectively in case of *"privatization and regulation"* are together. However, in both fixed effects model and to Hausman – Taylor model, total number of the subscribers increases by 44.6% and 48.4% respectively in case "privatization, liberalization and regulation" are practiced together. And this means that *"privatization and regulation"* without liberalization have a negative impact in 2nd Group OECD countries and the practice of *"privatization, liberalization and regulation"* together is more efficient.

Besides, according to the random effects model, it is determined that having practiced only the regulation decreases total number of the subscribers by 23.2%. Along with that, according to the random effects model, total number of the subscribers increases by 44.8% if the "regulation and liberalization" are practiced together. It is inferred from here that only the regulation does not give the expected result on total number of the subscribers and also the competition should be established after practicing the regulation with liberalization.

According to fixed effects, random effects and Hausman–Taylor models, it has been determined that real GDP per capita and prices have a negative impact on total number of the subscribers. With this respect, while an increase is theoretically expected in the number of the subscribers with the increase in real GDP per capita, it is seen that an increase in real GDP per capita by 1% decreases the total number of the subscribers in the 2nd Group OECD countries by about 0.15% in three models. The reason for the decrease in that total number of the subscribers in spite of the increase in the income per capita is considered to be the increasing competition, spreading the all-directions tariffs and cancellation of the second subscriptions due to number transferability in the 2nd Group OECD countries. However, as being appropriate to the theory, it is seen in three models that the increase in the prices leads to decrease in the number of the subscribers in the 2nd Group OECD countries. Finally, it is determined that privatization alone by itself increases the total number of the subscribers by 8.4% only in the Hausman– Taylor model in accordance with the H_1 hypothesis.

Being related to the impacts of the reforms practiced in 1st and 2nd Group OECD countries on total number of subscribers, it can be stated that some models can produce meaningful results in some cases, inferring from that some hypotheses, which were said to be tested in the previous chapter, have been checked. The Hypothesis$_1$ *(H_1)* arguing that only the *"privatization"* affects the total number of the subscribers positively has been proved with the Hausman–Taylor Model for the 2nd Group OECD countries and meaningful results could not be acquired with fixed effects and random effects model. The H_2 arguing that only the *"liberalization"* or only the *"privatization"* increases the total number of the subscribers is proved under both fixed effects and random effects models for the 1st Group OECD countries. The H_3 arguing that *"privatization and liberalization"* together affect the total number of the subscribers positively could not be proved with three models for both groups of country. In other words, a meaningful impact of *"privatization and liberalization"* without *"regulation"* on total number of the subscribers could not be determined. When "privatization and regulation" reforms have been practiced together, total number of the subscribers in 1st Group OECD countries increases according to Hausman–Taylor model and it is confirmed by the H_4 number of the subscribers. However, according to fixed effects and Hausman–Taylor models for the 2nd Group OECD countries, the practice of "privatization and regulation" together decreases the total number of the subscribers in contrast to the hypothesis about the number of the subscribers. The H_5 arguing that in case of the practice of "liberalization and regulation" together, total number of the subscribers will increase has been confirmed only by random effects model for the 2nd Group OECD countries. Finally, in case of practice of *"privatization, liberalization and regulation"* together, H_6 was confirmed that total number of the subscribers will be affected positively according to fixed effects and Hausman– Taylor models.

The analysis results related to the impacts of the reforms for the telecom sector on the sectoral employment in the 1st and 2nd Group OECD countries are in the Appendix 3.

When considered the impacts of the reforms in the telecommunication sector on the total employment, it is seen that in 1st Group OECD countries, "regulation and liberalization" together have a positive impact according to fixed effects model *(supports H_5)*; only regulation by itself and only liberalization by itself have a positive impact according to random effects model *(supports H_2)*; only privatization by itself has a negative impact on the employment according to Hausman – Taylor model *(supports H_1)* and only liberalization by itself *(supports H_2)* and *"privatization, liberalization and regulation"*

(supports H_6) have a positive attribute on the employment. Any meaningful results related to that *"privatization and liberalization"* together *(H_3)* and *"privatization and regulation"* together *(H_4)* have a negative impact on the employment.

It is concluded that in 2nd Group OECD countries, only privatization by itself has a negative impact on the employment in three models. On the other side, only liberalization by itself creates a negative impact on the sectoral employment according to three models. It had been stated that only liberalization by itself could have an increasing effect for the sectoral employment according to the H_2. In this case, H_2 arguing that only liberalization by itself has a positive impact on total employment in the 2nd Group OECD countries, which are consisted of the countries below the OECD average income, should be rejected. In other words, it would be "only liberalization by itself has a negative impact on the employment". When liberalization policies for the telecommunication sector in the 2nd Group OECD countries are implemented by themselves; they may have a negative impact on the employment. With this respect, policy makers have to take into consideration that in case of the practice of only liberalization without privatization and regulation, employment may be affected negatively. On the other hand, in case of the practice of "privatization and liberalization" together without a regulatory authority, total employment in three models is affected negatively *(supports H_3)*. In the analysis made for the 2nd Group OECD countries, according to Hausman–Taylor model, the H_4 hypothesis arguing *"privatization and regulation"* together without liberalization decrease the total employment was supported. In case of the practice of *"regulation and liberalization"*, Hausman–Taylor model has supported the H_5 for 2nd Group OECD countries as it was the case for the 1st Group OECD countries according to fixed effects model. In other words, total employment in the 2nd Group OECD countries increases in case of the practice of *"regulation and liberalization"* together according to Hausman–Taylor model. Additionally, it is seen that total real investments have a positive impact on the sectoral employment in the 2nd Group OECD countries for three models. Finally, it has been revealed that the simultaneous practice of "privatization, liberalization and regulation" reforms do not have a meaningful impact on the total employment in the 2nd Group OECD countries *(The findings supporting the H_6 could not be acquired)*.

The results acquired from the models analyzing the impacts of the reforms for the telecommunication sector in the 1st and 2nd Group OECD countries on the prices are in the Appendix 4.

As we analyze the impacts of the reforms for the telecommunication sector in the OECD countries on the prices that have the importance of effecting the choice of people, it is seen that only privatization by itself has given a meaningful result in the 1st Group OECD countries only according to Hausman–Taylor model, however it does not have a fee-decreasing effect as stated in H_1. In this respect, the practice of only privatization increases the prices instead of decreasing, in contrast with H_1. On the other side, it has been concluded that only privatization does not have a meaningful impact on the prices in the 2nd Group OECD countries. It has been inferred that only liberalization and only regulation separately do not have a meaningful impact on the prices for the 1st Group OECD countries *(Any meaningful result supporting the H_2 could not be acquired)*. Besides, any meaningful impact of only liberalization on the prices could not be determined; however, it has been revealed that only regulation increases the fees according to random effects model in contrast to what was stated in the H_2. Any meaningful result in both groups of countries for H_3 suggesting the decrease of the fees in case of the practice of "privatization and liberalization" together could not be acquired. In

case of the practice of *"privatization and regulation"* together, fees increase in 1st Group OECD countries according to Hausman–Taylor model and in the 2nd Group OECD countries according to fixed effects model, in contrast to H_4. For this reason, H_4 will be rejected. Any meaningful impact of the practice of *"liberalization and regulation"* together on the prices in the 1st Group OECD countries could not be determined. However, in the 2nd Group OECD countries, the prices decrease in case *"liberalization and regulation"* are practiced together according to random effects model *(H_5 is supported)*. In the 1st Group OECD countries, the practice of "privatization, liberalization and regulation" together increases the prices according to random effects model in contrast to H_6 hypothesis and for this reason, the hypothesis for the aforementioned group of country is rejected. On the other hand, the practice of "privatization, liberalization and regulation" together decreases the prices in the 2nd Group OECD countries according to fixed effects and Hausman–Taylor models, which supports H_6 hypothesis.

The results acquired from the models analyzing the impacts of the reforms for the telecommunication sector in the 1st and 2nd Group OECD countries on the labor productivity are in the Appendix 5.

When we analyze the impacts of the reforms for the telecommunication sector in the OECD countries on the labor productivity, it is seen that only privatization does not give a meaningful result for both 1st and 2nd Group OECD countries and the proofs supporting the H_1 could not be acquired. Whereas, it had been stated that a decrease in the employment with only privatization; and also the meeting this decrease in the employment with the increase in the labor productivity was expected. According to the results acquired through analyses, it has been determined that only privatization does not have a meaningful impact on the labor productivity. On the other side, it has been concluded that only liberalization does not have a meaningful impact on the labor productivity in the 1st Group OECD countries; however, only privatization increases the labor productivity in the 2nd Group OECD countries according to Hausman–Taylor model, and this means H_2 is supported by means of liberalization. On the other side, it has been concluded that only regulation does not have a meaningful impact on the labor productivity in both 1st and 2nd Group OECD countries.

Furthermore, it has been determined that the practice of *"privatization and liberalization"* together does not have a meaningful impact on the labor productivity in the 1st and 2nd Group OECD countries and the proofs supporting the H_3 could not be acquired. On the other hand, the practice of "privatization and regulation" reforms together decreases the labor productivity in the 1st Group OECD countries according to fixed effects and Hausman–Taylor models. For this reason, H_4 hypothesis is rejected. However, in case "privatization and regulation" are practiced together in the 2nd Group OECD countries for three models, an increase takes place in the labor productivity although liberalization has been established. For this reason, H_4 hypothesis is supported. Accordingly, while "privatization and regulation" without liberalization have a negative impact on the labor productivity in the 1st Group OECD countries, an increase in the labor productivity may occur with *"privatization and regulation"* in the 2nd Group OECD countries even if liberalization is not available. It can be stated that in case of adopting new technologies, the labor productivity may increase even if liberalization is not available in the countries that are below the OECD average income level and belong to the 2nd Group. In this respect, it must be noted that the aforementioned hypothesis may vary for the countries from different income groups.

It is expected that the practice of *"liberalization and regulation"* without privatization

increases the labor productivity. The labor productivity decreases in the 1st Group OECD countries according to Hausman–Taylor model whereas it decreases in the 2nd Group OECD countries for three models. For this reason, H_5 hypothesis is rejected. Finally, in the 1st Group OECD countries, the practice of *"privatization, liberalization and regulation"* together decreases the labor productivity according to random effects model and for this reason H_6 hypothesis is rejected. Also, it has been determined that any meaningful impact in the 2nd Group OECD countries could not be acquired.

7 Conclusion

Telecommunication sector, includes technological innovation accompanying with high market capitalization, has gained a great deal of importance in developed and emerging countries in the last two decades.

For the reason telecommunication sector has importance for economies to develop and grow, analyzing the impacts of the reforms for this sector comes into prominence. In this regard, investigating the economical effects on telecommunication sector is crucial. Privatization, liberalization and regulation reform works for the telecommunication sector have been analyzed in this empirical study.

The impacts of the reforms for the telecommunication sector on the total number of subscribers, total employment, prices and labor productivity in the OECD countries have been analyzed through the Fixed Effects Model, Random Effects Model and Hausman–Taylor Model among the panel data analysis methods in the empirical part of the study. Besides, OECD countries have been divided into two groups by their income levels to analyze the impacts of the economic development variations of the OECD countries.

Empirical results have revealed that the reforms of privatization, liberalization and regulation both separately and together have different impacts for the OECD countries of different income levels.

As a consequent, it has found out that data panel data analysis methods, known as efficient and valuable mathematical tools to analyze time series data, could give significant results in investigating the effects of privatization, liberalization and regulation on the telecommunication sector of OECD countries.

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Appendices

Appendix 1: Telecom Operators and Internet Service Providers in the OECD region as of the end of 2011

		Amount *(million US Dollar)*							**Unit**		
Country	No. of Firms	Revenue	Income	Long Term Debt	Capital Expenditures	Mobile Revenue	Employment	R-D	Fixed-Line Subscribers	DSL/Cable/ FTTH Subscribers	Mobile Subscribers
USA	14	405,634	10,558	270,962	58,230	168,902[5]	770,289	N.A.	93,091,276[7]	68,795,160[10]	286,597,500[7]
Japan	4	188,401	10,891	57,121	28,669	114,170[3]	264,886	3,449[3]	36,021,000[3]	26,505,000[3]	124,187,000[3]
Spain	1	86,300	7,420	76,442	12,477	52,592	291,027	N.A.	42,842,900	18,915,600	238,748,600
Germany	2	85,093	962	53,031	11,576	4,374[1]	243,042	169[1]	34,100,000[1]	16,900,000[1]	144,490,000
England	2	100,849	14,170	55,526	16,105	60,005[1]	176,462	1,834	35,223,000[1]	15,721,000[1]	404,691,000[1]
France	3	110,678	9,545	64,453	13,841[2]	27,128[2]	216,833[2]	819[1]	44,265,000[1]	19,714,000[2]	191,278,000[2]
Mexico	1	48,889	6,088	26,012	8,905	27,457	158,000	N.A.	29,000,000	15,000,000	242,000,000
Italy	1	54	-6,491	47,459	8,371	30,849	85,126	N.A.	21,712,000	N.A.	32,227,000
Netherlands	2	38,340	2,670	41,712	9,108	28,970	73,109	78[1]	9,339,000	15,014,000	239,343,000
Australia	1	19,338	2,582	8,996	2,994	8,236	41,183	6	8,234,000	3,319,000	11,744,000
Korea	3	36,408	2,423	11,589	6,540	21,048	59,125	422[2]	23,691,834	14,824,582	52,451,267
Canada	4	40,631	4,811	28,938	7,058	18,049[3]	110,000[3]	231[1]	13,553,472[3]	7,935,352	24,247,651[3]
Norway	1	15,376	1,118	3,483	2,070	23,120	33,000	131	1,714,000	1,665,000	140,422,000
Sweden,	2	18,749	2,988	10,425	2,971	15,163	35,929	78[1]	6,699,000	3,664,000	85,469,000
Switzerland	1	12,884	780	9,336	2,354	3,830	19,832	N.A.	3,426,000	3,437,000	6,049,000
Belgium	1	8,798	1,040	2,652	1,040	1,533	15,676	N.A.	4,794,000	N.A.	5,213,000
Turkey	2	13,273	2,079	2,975	2,352	7,454	36,774	17[1]	15,200,000[1]	6,800,000[1]	77,600,000
Greece	1	6,920	164	5,685	984	2,885	28,675	N.A.	5,921,000	2,233,000	20,467,000
Austria	1	6,118	-346	4,031	1,015	N.A.	N.A.	N.A.	2,608,700	1,465,100	20,266,200
Denmark	1	4,898	3,913	392	637	1,353	1,882	N.A.	1,401,000	928,000	2,891,000
Poland	1	4,693	603	1,309	820	N.A.	14,715	20	5,445,000	2,715,000	N.A.
Portugal	1	4,017	587	2,916	1,700	5,963	72,347	304	2,648,000	1,105,000	50,708,000
TOTAL	**50**	**1.297.839**	**78.559**	**785.445**	**199.815**	**623.081**	**2.747.912**	**7.559**	**440.930.182**	**246.655.794**	**2.401.090.218**

[1]: It is the data of only one operator. [2]: It is the data of only two operators. [3]: It is the data of only three operators. [5]: It is the data of only five operators. [7]: It is the data of only seven operators. [10]: It is the data of only ten operators.

Source: Data is provided from OECD (2013: 33).

Appendix 2: The Impacts of the Reforms for Telecommunication Sector in the OECD Countries on the Total Number of Subscribers (Model-1)

$$[TS_{it} = \alpha_{it} + \beta_0 PRV._{it} + \beta_2 LIB._{it} + \beta_3 REG._{it} + \beta_4 (PRV._{it}.LIB._{it}) + \beta_5 (PRV._{it}.REG._{it}) + \beta_6 D(LIB._{it}.REG._{it}) + \beta_7 (PRV._{it}.LIB._{it}.REG._{it}) + \beta_8 GDP\ per\ cap._{it} + \beta_9 P_{it} + \beta_{10} PD_{it} + \beta_{11} SA_{it} + \varepsilon_{it}]$$

	1st Group OECD Countries			2nd Group OECD Countries		
Variables	Fixed Effects Model	Random Effects Model	Hausman – Taylor Model	Fixed Effects Model	Random Effects Model	Hausman – Taylor Model
Equation cons.	16.41497*** (0.078533)	-0.8179167** (1.244045)	-2.235273** (1.034455)	18.21374*** (0.9257668)	18.20617*** (0.9731991)	9.178229*** (2.385303)
PRV	N.A.	N.A.	N.A.	N.A.	N.A.	0.080661** (0.0345587)
REG	0.1647944*** (0.0375031)	0.1466257*** (0.041632)	N.A.	N.A.	-0.264499*** (0.0859838)	N.A.
LIB	0.1823161*** (0.0584125)	0.1530778*** (0.0530699)	N.A.	0.2179825** (0.0871952)	0.2003901** (0.904015)	0.2312298*** (0.0346958)
PRV & REG	N.A.	N.A.	0.0946256*** (0.0226859)	-0.2621935*** (0.0842178)	N.A.	-0.3098855*** (0.0919827)
PRV & LIB	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
REG & LIB	N.A.	N.A.	N.A.	N.A.	0.3702201*** (0.0658555)	N.A.
PRV&LIB&REG	N.A.	N.A.	N.A.	0.368894*** (0.0618541)	N.A.	0.3950542*** (0.0912548)
GDP per capita	N.A.	0.1506076* (0.1049717)	0.1942202*** (0.0582688)	-0.1568891* (0.0983161)	-0.1512048* (0.0948555)	-0.1531645*** (0.0408063)
P	N.A.	N.A.	0.0877734*** (0.0275758)	-0.1275092*** (0.0451809)	-0.1362042*** (0.0423425)	-0.1211404*** (0.0392705)
PD	N.A.	0.9624952*** (0.0149736)	0.9815642*** (0.0659837)	N.A.	N.A.	N.A.
SA	N.A.	0.9572924*** (0.0119315)	N.A.	N.A.	N.A.	0.6016429*** (0.1946728)

* Significance at 10% level.

** Significance at 5% level.

*** Significance at 1% level.

Figures in parentheses are the error terms except the Hausman - Taylor Model show the "robust" standard error terms.

While "privatization and regulation" variable has been determined as the endogen for the 1st Group OECD countries in Hausman Taylor model, "privatization", "liberalization", "privatization and regulation", "privatization, liberalization and regulation" variables have been determined as the endogen for the 2nd Group OECD countries.

N.A.: Not available.

Appendix 3: The Impacts of the Reforms for Telecommunication Sector in the OECD Countries on the Total Employment (Model-2)

$$[TE_{it} = \alpha + \beta_1 PRV._{it} + \beta_2 LIB._{it} + \beta_3 REG._{it} + \beta_4 (PRV._{it}.LIB._{it}) + \beta_5 (PRV._{it}.REG._{it}) + \beta_6 D(LIB._{it}.REG._{it}) + \beta_7 (PRV._{it}.LIB._{it}.REG._{it}) + \beta_8 GDPPC_{it} + \beta_9 TI_{it} + \beta_{10} PD_{it} + \beta_{11} SA_{it} + \varepsilon_{it}]$$

	1st Group OECD Countries			2nd Group OECD Countries		
Variables	Fixed Effects Model	Random Effects Model	Hausman – Taylor Model	Fixed Effects Model	Random Effects Model	Hausman – Taylor Model
Equation cons.	-2.663114 (4.360735)	-5.277289*** (0.4712587)	-15.79045*** (4.979912)	4.751209 (4.334587)	-0.655402 (1.651479)	-1.287082 (2.345972)
PRV	N.A.	N.A.	-0.2000749*** (0.0590662)	-0.3341233** (0.1578775)	-0.3430285** (0.1462046)	-0.3197261*** (0.0719899)
REG	N.A.	0.136825** (0.0747651)	N.A.	N.A.	N.A.	N.A.
LIB	N.A.	0.1643472** (0.0706256)	0.2135201*** (0.0457953)	-0.209489* (0.118434)	-0.1782944* (0.1087121)	-0.2718486*** (0.0713559)
PRV & REG	N.A.	N.A.	N.A.	N.A.	N.A.	-0.272929*** (0.0792182)
PRV & LIB	N.A.	N.A.	N.A.	0.2454845** (0.1006343)	0.2488655*** (0.093867)	0.3089802*** (0.0814383)
REG & LIB	0.1130738* (0.0799429)	N.A.	N.A.	N.A.	N.A.	0.2180802*** (0.0765196)
PRV &LIB & REG	N.A.	N.A.	0.1597747*** (0.0559051)	N.A.	N.A.	N.A.
GDP per capita	N.A.	N.A.	N.A.	-0.3657056*** (0.1136521)	N.A.	-0.3866031*** (0.0705028)
TI	N.A.	N.A.	0.0992615*** (0.0308103)	0.1219217* (0.078939)	0.1380664** (0.0747721)	0.133929*** (0.0372443)
PD	3.195117*** (1.080828)	0.8802057*** (0.0390005)	1.996153*** (0.3186301)	1.791418** (0.891264)	0.9862447*** (0.1392126)	1.160925*** (0.1829089)
SA	N.A.	0.9503437*** (0.0345675)	1.422525*** (0.3487142)	N.A.	0.7384204*** (0.0753979)	0.7799306*** (0.1486485)

* Significance at 10% level.

** Significance at 5% level.

*** Significance at 1% level.

Figures in parentheses are the error terms except the Hausman - Taylor Model show the "robust" standard error terms.

While "privatization" "liberalization" and "privatization, liberalization and regulation" variables have been determined as the endogen for the 1st Group OECD countries in Hausman Taylor model, "privatization", "liberalization", "privatization and regulation", "privatization and liberalization" and "regulation and liberalization" variables have been determined as the endogen for the 2nd Group OECD countries.

N.A.: Not available.

Appendix 4: The Impacts of the Reforms for Telecommunication Sector in the OECD Countries on the Prices (Model-3)

$$[P_{it} = \alpha + \beta_1 PRV._{it} + \beta_2 LIB._{it} + \beta_3 REG._{it} + \beta_4 (PRV._{it}.LIB._{it}) + \beta_5 (PRV._{it}.REG._{it}) + \beta_6 D(LIB._{it}.REG._{it}) + \beta_7 (PRV._{it}.LIB._{it}.REG._{it}) + \beta_8 GDPPC_{it} + \beta_9 TI_{it} + \beta_{10} TR_{it} + \beta_{11} TS_{it} + \beta_{12} PD_{it} + \beta_{13} SA_{it} + \varepsilon_{it}]$$

	1st Group OECD Countries			2nd Group OECD Countries		
Variables	Fixed Effects Model	Random Effects Model	Hausman – Taylor Model	Fixed Effects Model	Random Effects Model	Hausman – Taylor Model
Equation cons.	N.A.	-0.0087902 (0.1750734)	7.614241* (4.643268)	-1.235618 (0.9603798)	-0.0453232 (0.5494312)	-1.785961 (1.834747)
PRV	N.A.	N.A.	0.1415731** (0.0710271)	N.A.	N.A.	N.A.
REG	N.A.	N.A.	N.A.	N.A.	0.1028476*** (0.0249299)	N.A.
LIB	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
PRV & REG	N.A.	N.A.	0.1080136* (0.0699577)	0.1337585*** (0.0152696)	N.A.	N.A.
PRV & LIB	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
REG & LIB	N.A.	N.A.	N.A.	N.A.	-0.2531303* (0.1555275)	N.A.
PRV&LIB&REG	N.A.	0.2585607 (0.1852132)	N.A.	-0.2919252* (0.1782669)	N.A.	-0.1270547*** (0.0454321)
GDP per cap.	N.A.	N.A.	N.A.	0.1645364 (0.1078003)	0.1785837* (0.1149338)	0.3381257*** (0.0965634)
TI	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
TR	N.A.	N.A.	N.A.	N.A.	N.A.	-0.1754236*** (0.068873)
TS	N.A.	N.A.	0.3940522*** (0.113588)	N.A.	N.A.	-0.1955753*** (0.0707241)
PD	N.A.	N.A.	-1.193786*** (0.3446352)	N.A.	-0.2431578* (0.1595234)	N.A.
SA	N.A.	N.A.	-0.7199979** (0.3338926)	N.A.	N.A.	0.3240718*** (0.1152879)

* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.
Figures in parentheses are the error terms except the Hausman - Taylor Model show the "robust" standard error terms.
While "privatization" and "privatization and regulation" variables have been determined as the endogen for the 1st Group OECD countries in Hausman Taylor model, "privatization, liberalization and regulation" variable has been determined as the endogen for the 2nd Group OECD countries.
N.A.: Not available.

Appendix 5: The Impacts of the Reforms for Telecommunication Sector in the I. OECD Countries on the Labor Productivity (Model-4)

$$[LP_{it} = \alpha + \beta_1 PRV._{it} + \beta_2 LIB._{it} + \beta_3 REG._{it} + \beta_4 (PRV._{it}.LIB._{it}) + \beta_5 (PRV._{it}.REG._{it}) + \beta_6 D(LIB._{it}.REG._{it}) + \beta_7 (PRV._{it}.LIB._{it}.REG._{it}) + \beta_8 GDPPC_{it} + \beta_9 TS_{it} + \beta_{10} PD_{it} + \beta_{11} SA_{it} + \varepsilon_{it}]$$

	1st Group OECD Countries			2nd Group OECD Countries		
Variables	Fixed Effects Model	Random Effects Model	Hausman – Taylor Model	Fixed Effects Model	Random Effects Model	Hausman – Taylor Model
Equation cons.	0.4141047***	0.3225925***	1.42702	-0.5654732*	-0.6433858**	-0.1995216
	(0.0498664)	(0.056631)	(1.308031)	(0.3232604)	(0.280469)	(0.3845594)
PRV	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
REG	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
LIB	N.A.	N.A.	N.A.	N.A.	N.A.	0.0265908*
						(0.0170741)
PRV & REG	-0.0586042*	N.A.	-0.0392286***	0.0810445***	0.0752505***	0.0863447***
	(0.0368207)		(0.0141292)	(0.026138)	(0.0235677)	(0.0215812)
PRV & LIB	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
REG & LIB	N.A.	N.A.	-0.0237123*	-0.0389*	-0.0395105***	-0.0390227*
			(0.01462)	(0.0246038)	(0.023191)	(0.0226287)
PRV&LIB&REG	N.A.	-0.0617241*	N.A.	N.A.	N.A.	N.A.
		(0.03921)				
GDP per cap.	N.A.	N.A.	0.0867255***	0.0828517**	0.0911437***	0.0838991***
			(0.0299898)	(0.0316945)	(0.0283163)	(0.0177236)
TS	N.A.	N.A.	N.A.	N.A.	N.A.	-0.0495517***
						(0.0195725)
PD	N.A.	0.0235311**	-0.2209443***	N.A.	N.A.	N.A.
		(0.0100644)	(0.0872432)			
SA	N.A.	N.A.	-0.1064402	N.A.	N.A.	0.0359423
			(0.0881987)			(0.0254561)

* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.
Figures in parentheses are the error terms except the Hausman - Taylor Model show the "robust" standard error terms.
While "privatization and regulation" and "regulation and liberalization" variables have been determined as the endogen for the 1st Group OECD countries in Hausman Taylor model, "liberalization", "privatization and regulation" and "regulation and liberalization" variables have been determined as the endogen for the 2nd Group OECD countries.
N.A.: Not available.