ECONOMETRIC STUDY ON THE IMPACTS OF PRIVATIZATION, NEW ENTRY, AND INDEPENDENT REGULATOR ON MOBILE PENETRATION AND EXPANSION IN DEVELOPING COUNTRIES

by

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ABSTRACT

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In this study, we analyze the effect of telecommunication reform variables (privatization, competition and Independent regulator) on mobile penetration using a panel dataset of 46 developing countries, which covers the period 1995-2016. Using fixed effect model to estimate the correlation between reform variables and our dependent variable we find positive and statistically significant correlation between competition level and mobile penetration rate. The results also suggest that privatization per se is associated with increase in the mobile cellular subscriptions per 100 people. The results indicate that while existence of an independent regulator a long with privatization increase the mobile penetration, presence of independent regulator although positive but not significantly correlated with mobile penetration.

Keywords: Telecommunication, Privatization, Competition, Independent Regulator, Mobile Penetration

ÖZET

GELİŞMEKTE OLAN ÜLKELERDE ÖZELLEŞTİRME, YENİ GİRİŞ VE BAĞIMSIZ DÜZENLEYİCİNİN MOBİL PENETRASYON VE GELİŞİMİ ÜZERİNE ETKİLERİNE DAİR EKONOMETRİK ÇALIŞMA

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Bu çalışma telekomünikasyon reformu değişkenlerinin (özelleştirme, rekabet ve bağımsız düzenleyici) mobil penetrasyon üzerine olan etkilerini, gelişmekte olan 46 ülkeyi ve 1995-2016 yıllarını kapsayan bir panel veri seti kullanarak analiz etmektedir. Reform değişkenleri ve söz konusu bağımlı değişken arasındaki korelasyonu tahmin etmek için sabit etkiler modeli kullanarak rekabet düzeyi ve mobil penetrasyon oranı arasında pozitif ve istatistiksel olarak anlamlı bir ilişki tespit edilmiştir. Ayrıca sonuçlara göre tek başına özelleştirme her 100 kişi için mobil cihaz aboneliği sayısında bir artışla ilişkilendirilmektedir. Sonuçlar bağımsız bir düzenleyicinin mevcudiyetinin özelleştirme ile beraber mobil penetrasyonu artırdığını gösterirken, bağımsız düzenleyicinin mevcudiyeti ve mobil penetrasyon arasındaki korelasyonun pozitif ancak anlamsız olduğunu göstermektedir.

Anahtar Kelimeler: Telekomünikasyon, Özelleştirme, Rekabet, Bağımsız Düzenleyici, Mobil Penetrasyon

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CHAPTER 1
INTRODUCTION

Telecommunications condition in developing countries is different from industrial countries in terms of structure, system quality, limitations and the speed of growth. Therefore assessment of telecommunication reforms in developed countries differs from their developing counterparts, although they were exposed to similar reforms. This paper focuses on the mobile network market in developing countries. First, because mobile network sector is now the most dynamic sector in telecoms in the world and also by its progressing technology it is a strong substitute for fixed lines. According to the ITU statistics (2016) the global fixed-line markets have shown recession by decreasing world average fixed-line penetration rate which was nearly at 20% since 2005 at its highest level and it reached to 13.4% in 2016, despite that the global mobile markets remain actively growing. World average mobile penetration rate in 2016 received to its highest level 100.6%, therefore, presently, the mobile market is better able to capture the dynamics of the telecom sector around the world.

In this study we conduct an econometric analysis to examine impact of privatization, level of competition and regulation of mobile sector on the network expansion in developing countries. Our data set includes an original panel dataset of 46 countries in Middle East and North Africa, Latin America, sub Saharan Africa and East Asia spanning 1995-2016.

Using a fixed effect models we find that stablishing separate regulator, privatization of incumbent and liberalization of the mobile network providers' is positively correlated with mobile deployment. Additionally the result indicates the positive effect of regulation while privatization is happening and competition shows the most effective factor of reforms on mobile penetration. Lastly, we use dynamic model, to detect the short-run effect of reform variables on growth of mobile penetration the results identify positive but not significant effect of establishing separate regulator, competition and privatization.

CHAPTER 2
LITERATURE REVIEW

The telecommunication reform start in era which Noll (1999) called it neoliberal reform era and before that, telecom was considered as a natural monopoly. This approach asserts that, minimum prices can be provided by a single company. As a result, telecommunication infrastructure in most of the developing countries stablished and expanded under control of government owned telecom companies where it caused ineffective and expensive services. Wallsten (2000). The reforms in 70's and 80's had two vital causes. The first one was the economic crises in the 1970s and 1980s that challenge many developing countries, reform was a solution to their debt crisis to decrease their debt and poor financial performance, and it also brought capital inflow for governments that could be used to stabilize macroeconomics variables in the country.

Second reason for privatization was dissatisfaction with the state-owned services like, poor service quality, low state-owned services quality, low productivity, and long waiting times for obtaining services (Ros, 1999). As countries introduced competition, particularly in the mobile telecommunications sector, they started to shift from monopoly supply approach, which was working over three-quarters of the last century and dominated the world's telecommunications markets, to competitive supply approach. It was obvious that nationalized monopoly telecommunications firms in developing countries suffered from serious issues, particularly low investment level. These problems were mainly due to governments' manipulation in telecommunication markets and the suboptimal tariffs imposed by them. The low tariffs in most of cases were not attractive enough to absorb necessary investment in response to growing demand for the telecommunication services (Kessides, 2004).

Given the background telecommunication reforms in developing countries initiated with perspective of a positive-sum game in which all the players in society will benefit from it. Assumptions of these reforms are that government by implementing various policies and considering market imperfections can legitimate liberalization and promote competition (Noll, 1999).

In the existing literature, telecommunication reforms investigated mainly from three aspects: first, ownership structure of incumbent firm and transition process that imposed to it, second introducing competition and competition level in the market, third, considering telecommunication industry structure establishing an independent industry regulator which regulate telecommunication market just based on market necessities.

Wallsten (2001) argues that in developing countries due to various reasons each part of the reforms can be realized in different ways. For instance, in most of the cases privatization is not perfect and it was conducted in a defective way. The government most of the time initially hold partial ownership of the incumbent, they also may constrain competition temporary in order to attract new investors. Likewise, regulator performs in such a way that can have large and uncontrolled influence on the performance of the telecommunication sector.

Levy and Spiller (1994) adds that, given the background and institutional structure of countries, reliability and efficiency of telecommunication sector also the effectiveness of reforms can variate. Where, in most of developing countries these institutional differences along with (usual) political and economic instability affecting the telecommunication reforms variables (privatization, competition and regulatory) such that it may completely alter the reforms expected results from what we plan and anticipate.

2.1. Effect of Privatization, Competition, and Separate Regulator

Changing the inculmbent ownership from public to private necessarily won't result in network expansion, for instance in a state-owned company the demand for network may be higher as a result of inefficiency in price setting and prices set by government may be lower costs and this cause excessive increase in the demand. The expectation is that after privatization, productivity of labor and allocation of sources improve. The logic for this assumtion comes from the idea that privatization transfers control power both for human and financial sources to private owners. However, private firms are also confronted with government intervention often times though it is less possible than their public counter parts. This can be due to the point that generally privetization

increase the cost of intervention in decision making process of privet companies for governemnts.

Privetization also can benefetial through increasing total factor productivity of state owned firms. As Vickers and Yarrow (1998) argue, that managers of public enterprises face less incentive to cut the extra costs since they cannot directly benefit from cutting the expences Because of incentives for impelemnting innovative cost controlling ways, we expect to have higher total factor productivity after privatization of the telecommunications sector.

According to the theory of monopoly market when one firm is able to fulfill total industry demand at lower cost it is more beneficial to have one big company rather than number of companies, on the other hand, establishment of a sustainable natural monopoly is not always possible, in this case, competition may have positive effect on main line network expansion. (Ros, 1999). In Telecommunication reforms literature many scholars and articles admit that introduction of competition in the telecom sector has been beneficial especially in terms of access to the services (GASMI, MAINGARD, & NOUMBA, 2012).

In evaluating the effect of telecommunication privatization, according to Ros(1999) prosperity level of privatization can depend on regulatory structure which is influenced by political and institutional position of conutries. Similarly Spiller (1995) emphasized on the effect of adequate regulatory system and asserts that most of the time two major reasons stop countries from having a competent regulatory system, firstly lack of constitutional protection against administrative expropriation. Second neglecting the fact that all sophisticated theoretical regulatory frameworks do not work for all countries and they should design their own convenient method which suits the country's structure.

2.2. Econometric Studies and Endogeneity Problem

To investigate the effect of telecommunication reforms some of the researchers conduct econometric analyses. In this section we will look at some of those studies in more details. Ros (1999) studied the effects of privatization and competition on fixed-line network expansion and efficiency in a sample of 110 countries during 1986-1995 time period. Using a fixed-effects model he found that private ownership of

telecommunication provider, was positively correlated with main lines per 100 inhabitants' variable, but competition, not found to have effect on network fixed-line expansion. Ros sample was mixture of 110 developed and developing countries, which can generate a lot of heterogeneity and possibly bias the results. He tried to solve this problem by separating the studied countries to countries with GDP per capita below and above $10,000.

It is important to note that decision of the telecom sector start privatization, may not be an exogenous decision, it can be the case that countries with worse financial position are more likely to privatize. Reforms affect dependent variable, telecom performance, but performance may also affect reforms. In addition unobserved factors affecting reform may also affect performance. Therefore, studying the effect of regulation and privatization on dependent variable under the assumption of reform variables are exogenous, is problematic.

Ros(1999) deal with endogeneity problem by estimating two logit models where the dependent variable is competition or privatization and explanatory variables are network expansion, efficiency, GDP per capita lagged one year, Investment per line lagged one year, by using the logit model, he first model the decision to privatize or permission of competition as a discrete choice. In the logit model, regressors are exogenous, then he will use the predicted probabilities interacted with the observed dummy variables as instrument in the second estimation processes. However beside this try to solve the issue the result does not vary too much from the model with exogenous assumption.

Wallsten(2001) in variant study by using Fixed-effects regressions, analyses the effect privatization, competition, and regulation of mainlines on performance in 30 Latin American and African countries from 1984 through 1997, he found that increasing competition increases the per capita number of mainlines, payphones, and connection capacity. Privatization interacted with an independent regulator is correlated with telecom performance positively. Despite that, Privatization per se, is identified with few benefits, and is negatively correlated with network capacity. Regulation interacted with competition had no significant impact.

Wallsten also acknowledged his study weaknesses by highlighting the endogeneity problem which we explained earlier, is the possibility that competition,

privatization and regulation may be endogenous to reforms. He tried to solve the endogeneity problem by including country and year fixed-effects and a variable indicating whether the country passed reform legislation. Country fixed-effect control for a country-specific tendency and ability to reform, and year fixed effects control for general history and flows of changes in telecom service.

A paper by Gutierrez (2003) look at the relation between endogenous regulation and fixed line telecommunications expansion and efficiency for a sample of 22 Latin American countries during the period 1980-1997. His main results showed that regulatory governance in telecommunications influence network expansion and efficiency positively, in both the static and dynamic specifications. Competition and deprivation of former state-owned telecom operators also result in improving sector performance. The dynamic specifications showed that previous performance had strong effect on present performance. Gutierrez (2003) utilize Panel data techniques to conduct the econometric analysis for both static and dynamic models. Additionally, he includes time dummies since the data duration is eighteen years, it is acceptable for capturing changes in economic and industry environment. He argues that since in the period under study, Latin American economic and political situation underwent important events, and also telecommunications was subjected to dramatic technological changes at the same time, therefore, it seems necessary to for time effect along with countries fixed effects. The dependence of the reform variables on past achievements is shown by inclusion of lagged values of the endogenous behavioral variables where he solves the endogeneity problem by using Arellano and Bond's GMM estimator. Lagged dependent variable can explain network expansion and it may show the importance of investment.

Li (2008) study was a different contribution to the telecommunication reform literature from earlier papers we have discussed till now, since he analyses impacts of privatization, New Entry, and independent industry regulator on mobile network penetration and expansion on 30 national mobile markets (i.e. 29 OECD countries and China) over the time period 1991-2006, till now all the studies were demonstrating the fixed line network deployment but this study is focusing on the mobile market and mention the reasons as, first perpetual progress in the wireless network technology and second he found mobile network services a powerful substitutes for fixed lines. This study is also important regarding it is analyzing more developed countries and the time

period is more recent. The study investigate the reform variables relationship by employing a structural model based on logistic growth model, with considering potential endogeneity by mobile service price and labor productivity(mobile price and labor productivity are two endogenous explanatory variables, means the independent regulator(dependent variable) also has impact on labor productivity and mobile price). The estimation result confirms that introducing new entry is positively correlated with mobile network penetration and expansion, particularly entry of third mobile operator is correlated with the network expansion rapidly. The study also focused on the role of independent regulator in a long with the privatization, and found that an independent regulator in privatized mobile markets is positively correlated with the network expansion on the other hand, privatization per se, on average, negatively correlated with mobile network expansion. The results of dynamic model also acknowledge these conclusions.

Generally empirical studies about a developing country is scare however, there is some studies about mobile diffusion from emerging and developed economies. Gruber (2001) using a logistic fixed-effects model, explores the diffusion of mobiles in Central and Eastern Europe, and found positive relationship between the speed of mobile diffusion and the number of firms, the size of the fixed telecommunications network and the length of the waiting list.

Furthermore, Gruber & Verboven (2000) intent to empirically assess the role of technology and regulatory decisions as major determinants in the speed of diffusion of mobile telecommunications services in the European Union. This paper Using panel data on the whole history of the industry for all 15 member states of the EU, evaluate the relative importance of the following factors: technology, the timing of the first licenses granted, and the introduction of competition. The impact of the existing fixed line network and GDP per capita are also considered. Gruber & Verboven (2000) found that timing of the first entry, competition and mode of the second cellular entry are the major determinants of the speed of mobile diffusions although the effect of new entry was smaller than the technology effect. They also found that income (as measured by GDP per capita), main lines, the waiting list and technology have significant positive impact on the diffusion of mobiles.

Gebreab (2002) perform an empirical analysis on the determinants of the diffusion of mobile telecommunications in Africa by using fixed effects model for 41 African countries over the time period from 1987-2000. The determinants of mobile diffusion that this study has described classify into six main themes, including competition, existence of an incumbent-owned cellular, regulation, technological change, privatization. The estimation results confirms that competition is the major motivation causing the mobile expansion in Africa. Monopoly markets are the slowest in the speed of growth in comparison with both tripoly and duopoly markets. Additionally the study finds that the presence of an incumbent-owned cellular in mobile markets has negative impact on the diffusion of mobiles. This is compatible with the theory of an abuse of a dominant position. Gebreab (2002) did not find, any significant evidence to challenges the idea of differences between simultaneous and sequential entries. In sequential competitive entries, the major effect of competition on mobile growth appear after the actual year of entry.

On the other hand Gruber and Verboven (2000) in their global mobile communications study, found sequential entry is more effective. The result also highlight the positive and significant effect of digitalization, which accelerates the rate of mobile diffusion. This finding is consistent with the Gruber and Verboven (2000), where they also found positive effect of digitalization in their EU study. Finally, urbanization (measured by the percent of urban population) and main lines are positive and significant; the positive significance of the main lines variable indicate that mobiles are anticipated as complements to fixed lines.

CHAPTER 3
DATA

Our database is a panel data set contains information of 46 non-OECD countries with focus on developing countries in Middle East and North Africa, sub-Saharan Africa, Latin America and East Asia from 1995-2016 (lists of countries shown in Table I), they are selected based on data availability. This point is important since for constructing the countries sample we did not consider their telecommunication sector performance. We also exclude countries that facing domestic or international war like Syria.

Table 1

Countries in telecommunications database

Latin America	Sub Saharan Africa	MENA	Asia
Argentina	Angola	Algeria	Sri Lanka
Brazil	Gabon	Egypt	Malaysia
Bolivia	Namibia	Iran	Indonesia
Costa Rica	South Africa	Morocco	Thailand
Colombia	Niger	Tunisia	China
Dominican Rep.	Nigeria	Lebanon	Pakistan
Ecuador	Senegal	Jordan	India
Guatemala	Malawi	Yemen	Bangladesh
Paraguay	Zambia	Oman	Philippines
Peru	Cameroon	Kuwait	
Uruguay	Uganda	Saudi Arabia	
Honduras			
El Salvador			
Nicaragua			
Vietnam			

The data set covers both group of countries which privatized or not privatized their incumbents firms in mobile providers markets, this prevents our analysis from having sample selection biases that might happen if only one group (privatized and not privatized) of countries used in the sample.

Using network deployment (Mobile cellular subscriptions per 100 people) as the dependent variable, we investigate its relationship with three main dimensions of telecommunications reform, where they define as main explanatory variables in our models. Information on Mobile cellular subscriptions (per 100 people) and existence of a separate regulator, come from the International Telecommunications Union (ITU) dataset. We collect information about Number of mobile operators in each year for each country from mobile operators' websites.

The Privatization defines as a dummy variable that equals to one from the beginning of the year that the incumbent firm become privatized, and zero if the incumbent mobile operator had not been privatized. We define a privatized frim when more than 50% of its share belongs to private owners. One important point about the privatization dummy is it does not show the quality of privatization; it just indicate that whether the government sold major part the firm or not.

Competition variables indicates the number of mobile operators which are not owned by the incumbent. We consider different dummy variables for each new competitor in the countries' market.

To investigate effect of existence of separate regulatory agency we define a dummy variable indicating presence of separate regulator inn each studied country. In our data set separate regulators are assumed as independent decision makers where they not directly under control of government. Again it is important to note that displaying independent regulator by the dummy variable is an oversimplification of regulation. For better assessment we need to know type of regulatory task that propose by each regulator.

As an another telecommunication explanatory variable , following Li (2008) we use fixed-line penetration to consider for the supply factor that may affect mobile penetration and also The fixed-line penetration shows the infrastructure potential of the country and the capicity of mobile services supply.

Our dataset include GDP per capita, national population and urban population ratio (the percentage of total population live in urban areas) as other exogenous control variables. We retract these macroeconomics and demographic variables from World Bank data set. Importantly, all variables, except for dummies, were converted to natural logarithmic form.

While there are lots of factors influencing the performance of privatization and competition, data constraints prevented us from being formally modeled therefore we should take this to account in any conclusion which we are reaching here.

3.1 Variables Description

The variables included to test the hypothesis of whether reforms have effect on mobile network penetration are: privatization dummy (Prv_{it}), independent regulator dummy ($Indp_{it}$), and their interaction term ($itcInP_{it}$). The interaction term is added to explore effects of regulation while privatization is taking place. In other words this term shows how regulation and privatization together correlate with mobile network performance.

To have controls for some market dependent factors that may affect mobile penetration rate in the countries. Particularly, we include GDP per capita ($GDPhead_{it}$), as a proxy for income level of individuals. Income level can affect the demand for telecommunication services in the countries. We also include fixed telephone subscriptions (per 100 people) ($fixline_{it}$) to control for level of telecommunication infrastructure in the countries where it may have role in supply of mobile services. Here we assume that the countries with higher level of fixed line network have better infrastructure for mobile network expansion. However, as explained by Li (2008), the size of fixed line network may have positive or negative effect on mobile network expansion as it can be complements or substitutes for mobile network.

We try to confront with the endogeneity problem (i.e. macro-characteristics of countries' that affect the reform variables performance and mobile network expansion) by controlling for features of countries that may lead the governments to conduct the reform in telecommunications market in order to stabilize macroeconomics, financial or political situations in the country. This eliminate the exogenity of the privatization, to deal with this problem we use International Country Risk Guide (ICRG) database, to define Political (Pol_risk), Economic (Eco_risk), Financial (fin_risk) Risk ratings of the countries. Each one of the variables is defined as average value of several related index. The indexes spans between 1 and 10 where 10 indicates the lowest and 1 indicates the highest risk, respectively. Specifically, political risk is defined as average value of Government Stability, Socioeconomic Conditions, Investment, Internal Conflict, Bureaucracy Quality, and Corruption indexes. Economic risk is made as

average value of indexes about Real GDP Growth, Annual Inflation Rate, Current Account as a Percentage of GDP, and Budget Balance as a percentage of GDP. Financial risk is defined as mean value of indexes include: Foreign Debt as a Percentage of GDP, Foreign Debt Services as a Percentage of Exports of Goods and Services, Current Account as a Percentage of Exports of Goods and Services, Net International Liquidity, and Exchange Rate Stability.

We include national population (Pop_{it}) to capture the national market size and time dummies used to control for technological progress and global business cycles that may impact the mobile network expansion. We also include control variable for measuring urbanization as a percentage of total population ($UbPop_{it}$), in the countries which may impact expansion of mobile network positively. It is logical to assume better mobile signal coverage, higher income level and life standards for individuals in urban areas, compare to rural areas, which may increase the possibility of using mobile services for them.

For first checkup of the data table 4 gives us first insight about the relationship between mobile deployment variable and reform variables in our data set. Specifically, Table 2 presents the correlation coefficient between the variable indicators of privatization, existence of separate regulator and number of competitors in mobile market and variable measuring telecommunication performance outcome (Mobile penetration rate). The relationship between privatization and mobile deployment is positive. The results also suggest relatively strong positive correlation between number of competitors in mobile providers market and penetration of mobile. Generating an independent regulator also positively correlate with mobile deployment. In the following section, we are going to investigate these relationships in our data set using econometric models.

Table 2

Correlation coefficients between privatization, competition and separate regulator with mobile penetration

	Privatization	No-Competitors	Existence of Separate Regulator
ln_mobile_subscription	0.1348	0.5924	0.4094

CHAPTER 4
ECONOMETRIC MODEL

We start our analysis with estimation of a simple OLS model. The Model (1) includes the privatization, and existence of an Independent regulator dummy variables. It also includes a set of dummies that indicate each new competitors in the countries mobile provides market. For example $D_2(comp)_{it}$ equals to one if a second mobile network competitors enters a market, and equals zero otherwise and so on.

As mentioned, in the model (1) we add all the three dimensions of telecommunication reform ($Prv_{it}, (comp)_{it}, Indp_{it}$) along with interaction term of privatization and separate regulator ($itcInP_{it}$) to see how regulation and privatization jointly correlate with mobile penetration. We include our control variables for demand ($lnUbPop_{it}, lnGDPhead_{it}$) and supply side ($lnfixline_{it}$) of the market which may have effect on the mobile penetration rate in the sample countries. Importantly we control for time fixed effect (T) which is time effect dummies to consider the effect of technology progress and global economy cycles during the sample period.

$$\begin{aligned} ln\, y_{it} = \quad & \alpha_{1i} + \beta_{11} Prv_{it} + \beta_{12} D_j(comp)_{it} + \beta_{13} Indp_{it} + \beta_{14} itcInP_{it} \\ & + \beta_{15} lnGDPhead_{it} + \beta_{16} lnfixline_{it} + \beta_{17} lnUbPop_{it} \\ & + \beta_{1\,11} T + \varepsilon_{it} \end{aligned} \qquad (1)$$

Afterwards, we estimate a fixed-effect model by including fixed effect of countries in our first model. With the help of fixed effect models we can control unobserved heterogeneity fixed effects. Because of this point fixed-effect models are preferred to random models in estimation of relationships between telecom reform variables and telecommunication performance outcomes. Also, we run a Hausman test and the results reject the null hypothesis which tells: random effect is appropriate. The model (2) defines as:

$$ln\, y_{it} = \alpha_{2i} + \beta_{21} Prv_{it} + \beta_{22} D_j(comp)_{it} + \beta_{23} Indp_{it} + \beta_{24} itcInP_{it} + \beta_{25} lnGDPhead_{it} + \beta_{26} lnfixline_{it} + \beta_{27} lnUbPop_{it} + \beta_{28} T + u_i + \varepsilon_{it} \quad (2)$$

Model (3) is again a fixed-effect model where we add three macroeconomic risk variable to control for political, economic and financial risk of countries which may have some effect on our dependent variable or they may indirectly affect our telecommunication reform variables. The result is presented in third column of table 4.

$$ln\, y_{it} = \alpha_{3i} + \beta_{31} Prv_{it} + \beta_{32} D_j(comp)_{it} + \beta_{33} Indp_{it} + \beta_{35} lnGDPhead_{it} + \beta_{36} lnfixline_{it} + \beta_{37} lnUbPop_{it} + \beta_{38} fin_{risk} + \beta_{39} Eco_{risk} + \beta_{3\,10} Pol_{risk} + \beta_{3\,11} T + u_i + \varepsilon_{it} \quad (3)$$

Besides the points against random effect assumption in our analysis, For further examination about the robustness of fixed effect assumption, in model (4) which is exactly same as model (3) we run a random effect model to estimate the relationships. The random-effect model, assumes that any characteristic of a country that would not vary during the time of our sample and would not accounted for in the estimation (e.g. religion, geography, location with respect to equator) would may make some bias in the result.

$$ln\, y_{it} = \alpha_{4i} + \beta_{41} Prv_{it} + \beta_{42} D_j(comp)_{it} + \beta_{43} Indp_{it} + \beta_{45} lnGDPhead_{it} + \beta_{46} lnfixline_{it} + \beta_{47} lnUbPop_{it} + \beta_{48} fin_{risk} + \beta_{49} Eco_{risk} + \beta_{4\,10} Pol_{risk} + \beta_{4\,11} T + u_i + \varepsilon_{it} \quad (4)$$

As other sensitivity checks for our main model, instead of political risk indicator in model (3) we control for bureaucracy quality in model (5) and corruption level in model (6). In Model (7) we add interaction term of independent regulator and

bureaucracy quality as a control variable. Model (8) controls for interaction of independent regulator and corruption level. [1]

[1] We also intended to control for "the rule of law" index which indicate whether legal institutions protect competitors rights, but this index is not available for all years of our study.

CHAPTER 5

RESULTS AND DISCUSSION

Table 5 reports results of estimated models. The results are, in general, consistent with findings of the existing literature. As mentioned earlier, first column of table 5, reports the estimation result for an OLS model. The result suggest, holding other factors constant, privatization per se, regulatory reform per se, and their interaction term had positive but not significant impacts on mobile penetration. The results indicate that although privatization and existence of separate regulator has positive effect on mobile network penetration, their effect increase when they come together. As expected introducing new competitors are associated with improvement in mobile network expansion where generally seems increasing the competing level in the market is correlated with higher mobile penetration rate.

Second column of the Table 5 presents Model (2) results. The results suggest controlling for countries fixed effect improved the results. As it is shown Privatization and existence of separate regulator per se, are again positively correlated with the dependent variables where privatization coefficient in this model become significant in 90 percent confidence interval. The effect of privatization along with existence of separate regulator shows higher and this time statistically significant associated with mobile network penetration in the studied countries during the studied period. The coefficients of competitors show positive and statistically significant pattern for correlation of introducing new competitors and the telecommunication market outcome variable.

Third column of table 5 reports estimation result of Model (3) results. We can see by controlling for the risk factors of reform variables become larger and generally their significance level increase. Consistence with previous models result again shows privatization and separate regulator are positively correlated with the dependent variable. Their interaction term shows their simultaneous effect are higher than individual effect. This can interpret to better performance of privatized company in presence of separate regulator. The coefficients of new competitors show positive and statistically significant effect on mobile penetration rate. The increasing pattern of new competitors' coefficients suggest effectiveness of higher competition level on

telecommunication performance. The explanation for the positive effect of competition on the mobile penetration may because increasing the competition between mobile operators decrease the price of services and this will raise the demand for mobile services.

Fourth column of table 5 presents result for random effect model. The model results are generally consistent with fixed effect model results in third column. This suggest that the estimation result of our preferred specification (model 3), is not sensitive to fixed effect assumption.

Besides our interested variables the conducted econometric analysis suggests positive and statistically significant value for fixed-line penetration coefficient in model (1) and (2), while positive but not significant value in model (3). GDP per capita, our proxy variable for income level in each country, as expected is positively correlated with mobile penetration but it's relationship is statically significant only in model(1). Urban population ratio is also show positive correlation with mobile penetration rate. Finally, table 7 and 8 displays results for the robustness checks. As it is shown in table 7 controlling for level of corruption does not change our main findings regarding importance of competition level and privatization on mobile expansion rate in studied developing countries. Table 8 shows that considering countries bureaucracy quality or corruption levels in the time of establishing separate regulator also do not affect aforementioned findings.

CHAPTER 6
CONCLUSION

In this study, we conduct an econometric analysis for investigating the effects of privatization, competition and existence of an independent regulator on mobile penetration for panel dataset of 46 countries during 1995-2016. First we run a simple OLS model, and then we proceed by including fixed effect of countries in model (2), in the third model, which can consider as our preferred specification we have developed our fixed-effect model by including three macroeconomic risk variable to control for political, economic and financial risk of countries which may have simultaneous effect on reform variables and mobile network penetration rate. The results also examine by some robustness checks, where they support our main findings in the preferred specification.

Consistent with previous studies (Li, 2008) the results implies that competition is obviously associated with the increase in mobile penetration rate. The increasing pattern in coefficients of new competitors' dummies suggest importance of competition level in telecommunication outcomes. We find positively significant relationship of privatization and interaction of privatization with independent regulator with mobile deployment in our preferred model. The results suggest positive but not significant relation between existing an independent regulator with mobile deployment. This can be because of weak enforcement and design in the planning and execution of rules and policies.

Despite its shortcomings our work, has demonstrated that reforms in developing countries seems to be in the right track: encouraging competition and emphasizing on existence of independent regulatory when privatizing an incumbent telecom provider. However, the results still are far from conclusive and further studies are essential to address the main issues. In the future as quality and quantity of available data improve econometrics studies become more consistent and they provide deeper insights about the issues.

Future work can contribute to the literature by gathering data to address the issues such as; how privatization took place, type of regulation that enforced on privatized

firm and whether readjustment in prices happen before privatization, these information may help explain the results obtained in this paper or conclude different results.

REFERENCES

Fink, C., Mattoo, A., & Rathindran, R. (2003). A n assessment of telecommunications reform in developing countries. *World Bank*.

Gasmi , F., & Recuero Virto, L. (2008). The determinants and impact of telecommunications reforms in developing countries∗.

GASMI, F., MAINGARD, A., & NOUMBA, P. (2012). The Privatizaion of the Fixed line Telecommunications operators in OECD, Latin America, Asia, and Africa: One Size does not Fit All.

Gebreab, F. (2002). GETTING CONNECTED: Competition and Diffusion in African Mobile Telecommunications Markets. *World Bank Policy Research* .

Griliches, Z. (1957). Hybrid Corn: An Exploration in the Economics of Technological Change. *Econometrica, The Econometric Society*.

Gruber, H. (2001). Competition and Innovation: The Diffusion of Mobile Telecommunications in Central and Eastern Europe. *Information Economics and Policy*.

Gruber, H., & Verboven, F. (2000). The di!usion of mobile telecommunications services in the European Union. *European Economic Review*.

Gutiérrez, L. (2003). The Effect of Endogenous Regulation on Telecommunications Expansion and Efficiency in Latin America. *Journal of Regulatory Economics*.

Kessides, I. N. (2004). *Reforming Infrastructure Privatization, Regulation, and Competition.* Washington, DC 20433 : World Bank and Oxford University Press.

Levy , B., & Spiller , P. (1994). The Institutional Foundations of Regulatory Commitment: A Comparative Analysis of Telecommunications Regulation. *JOURNAL OF LAW, ECONOMICS, AND ORGANIZATION, Vol 10, No 2*.

Li, W., & Xu, L. C. (2002). The Political Economy of Privatization and Competition: Cross-Country Evidence from the Telecommunications Sector. *Journal of Comparative Economics*, 439–462.

Li, Wei; Xu, Lixin Colin. (October 2002). The Impact of Privatization and Competition in the Telecommunications Sector around the World. *The World Bank*.

Noll, R. (1999). TELECOMMUNICATIONS REFORM IN DEVELOPING COUNTRIES. *University of Chicago Press*.

Ros, A. (1999). “Does Ownership or Competition Matter? The Effects of Telecommunications. *Journal of Regulatory Economics*, 65-92.

ROS, A. J. (2003). The Impact of the Regulatory Process and Price Cap Regulation in Latin American Telecommunications Markets.

Shleifer, A., Vishny, R., & Boycko, M. (1996). A Theory of Privatization. *Economic Journal 106, 309-319*.

T.Spiller, P. (1995). regulatory commitment and utilities privatization: implications for future comperative research. In E. A. edited by Jeffrey S. Banks, *Modern Political Economy: Old Topics, New Directions* (pp. 63-). Cambridge University Press.

Vickers, John ; Yarrow, George ;. (1988). Privatization: An Economic Analysis. *MIT Press, Cambridge*.

Wallsten, S. (2000). Telecommunications Privatization in Developing Countries:. *Stanford University and The World Bank.*

Wallsten, S. (2000). Telecommunications Privatization in Developing Countries: The Real Effects of Exclusivity Periods. *Stanford*.

Wellenius , B. (1997). Telecommunications Reform How to Succeed. *World Bank Group*.

Wellenius. (1992). Telecommunications: World Bank Experience and Strategy. *World Bank*.

Yan, L. (2008). Econometric Evidence on the Impacts of Privatization, New Entry, and Independent Industry Regulator on Mobile Network Penetration and Expansion. *ESRC Centre for Competition Policy, University of East Anglia*.

APPENDIX (I)

DYNAMIC MODEL

To further assessment of the impact of existing separate regulator, privatization and level of liberalization on mobile penetration rate within GSM providers market, we consider to study the short run effect of telecommunication reform variables in dynamic framework. Following Gutierrez (2003) we define a simple dynamic model by adding one period lagged dependent variable as new explanatory variable to the model (3). Hence, the dynamic model define as:

$$\begin{aligned} ln\, y_{it} = \alpha_{5i} \quad & + \gamma ln\, y_{it-1} + \beta_{51} D_j(comp)_{it} + \beta_{52} Prv_{it} + \beta_{53} Indp_{it} \\ & + \beta_{54} itcInP_{it} + \beta_{55} lnGDPhead_{it} + \beta_{56} lnPop_{it} + \beta_{57} lnUbPop_{it} \\ & + \beta_{58}\, fin_{risk} + \beta_{59} Eco_{risk} + \beta_{5\,10} Pol_{risk} + \beta_{5\,11} T + u_i + \varepsilon_{it} \end{aligned} \qquad (5)$$

We estimate the dynamic model using system GMM estimators method proposed by Arellano-Bover (1995) and Blundell-Bond (1998). We conduct the dynamic panel estimation using xtabond2 command in STATA software. The results for dynamic model reports in table 6 (presented in appendix II). The second Column of table 6 report long run effect of the telecommunication reform variables.

The results presents positive correlation between existence of separate regulator, and privatization, and their interaction with mobile penetration growth rate in short run. We find positive association between new competitors dummy and the dependent variable even in short run where it become statistically significant by introducing fourth competitors. This suggest higher effectiveness of competition even in short run.

It is important to note that, the result of dynamic model is not directly comparable with pervious models' results. Since in dynamic models we are analyzing the effect of the reforms variable on growth of mobile penetration in a short run.

APPENDIX (II)

TABLES

Table 3a

Summary statistics for telecom independent variables

Mena				South Asia			
Country	**Year independent regulator established**	**Year incumbent privatized**	**Number mobile competitors by 2016**	**Country**	**Year independent regulator established**	**Year incumbent privatized**	**Number mobile competitors by 2016**
Algeria	2001	N	3	Sri Lanka	1996	1995	5
Egypt	2003	1998	3	Malaysia	1998	1995	4
Iran	2003	N	4	Indonesia	2003	1995	5
Morocco	1997	N	2	Thailand	2010	N	4
Tunisia	2001	2005	3	China	2012	N	3
Lebanon	2007	1995	2	Pakistan	1996	1995	4
Jordan	1995	1995	3	India	1997	1995	5
Yemen	N	1995	4	Bangladesh	2002	1997	4
Oman	2002	N	2	Philippines	1995	1995	2
Kuwait	2015	1995	3				
Saudi Arabia	2001	N	5				

Table 3b

Summary statistics for telecom independent variables

Latin America				Sub Saharan Africa			
Country	**Year independent regulator established**	**Year incumbent privatized**	**Number mobile competitors by 2016**	**Country**	**Year independent regulator established**	**Year incumbent privatized**	**Number mobile competitors by 2016**
Argentina	2015	1995	4	Angola	1999	2001	2
Brazil	1997	1995	4	Gabon	2001	2007	3
Bolivia	1995	1995	3	Namibia	2011	N	2
Costa Rica	2008	2005	3	Mauritius	2002	1995	3
Colombia	1995	1995	4	South Africa	2000	1995	4
Dominican Rep.	1998	1998	4	Niger	2004	2001	4
Ecuador	1995	1995	3	Nigeria	1995	1995	6
Guatemala	1996	1996	4	Senegal	2001	1997	3
Paraguay	1995	1999	4	Malawi	1998	1995	2
Peru	1995	1995	4	Zambia	1995	N	3
Uruguay	2001	N	3	Cameroon	1998	1998	3
Honduras	1995	1995	4	Uganda	1997	1995	6
El Salvador	1996	1995	4				
Nicaragua	1995	1995	2				
Vietnam	2011	N	6				

Table 4

Descriptive statistics - mean by year

	Mob_sub	Fix_line	Sep_reg	Privet	Eco_risk	Fin_risk	Pol_risk	No_comp
1995	0.646	5.46	0.239	0.5	1.588	1.863	1.655	0.391
1996	1.036	5.977	0.326	0.522	1.643	1.855	1.665	0.435
1997	1.726	6.653	0.413	0.565	1.796	1.87	1.686	0.522
1998	2.466	7.168	0.413	0.63	1.891	1.902	1.677	0.587
1999	3.713	7.693	0.522	0.652	1.854	1.912	1.647	0.717
2000	6.168	8.193	0.543	0.652	1.92	1.918	1.638	0.848
2001	9.131	8.598	0.674	0.696	1.937	1.946	1.664	1.065
2002	12.392	8.887	0.717	0.696	1.91	1.925	1.634	1.174
2003	15.709	9.261	0.783	0.696	1.917	1.945	1.634	1.239
2004	21.551	9.794	0.804	0.696	1.95	1.991	1.652	1.522
2005	30.649	10.213	0.804	0.739	1.975	2.024	1.656	1.717
2006	41.405	10.412	0.804	0.739	1.995	2.042	1.658	1.783
2007	54.462	10.795	0.826	0.761	2	2.06	1.652	1.935
2008	66.886	11.071	0.848	0.739	1.991	2.066	1.644	2.109
2009	78.111	11.114	0.848	0.739	1.906	2.067	1.644	2.217
2010	87.742	10.67	0.87	0.739	1.925	2.098	1.638	2.391
2011	96.735	10.436	0.913	0.739	1.95	2.11	1.61	2.435
2012	102.149	10.304	0.935	0.739	1.94	2.096	1.599	2.457
2013	108.15	9.833	0.935	0.739	1.941	2.095	1.594	2.457
2014	110.179	9.394	0.957	0.739	1.946	2.086	1.592	2.565
2015	109.228	9.224	0.978	0.739	1.931	2.057	1.594	2.543
2016	109.297	9.291	0.978	0.739	1.888	2.05	1.596	2.543

Table 5
Regression results -Dependent variable mobile cellular subscriptions

	Model (1)	Model (2)	Model (3)	Model (4)
Independent regulator	0.0898 (0.2444)	0.1324 (0.2687)	0.3300 (0.2330)	0.3231 (0.2317)
Privatization	0.2546 (0.2931)	0.9533* (0.4552)	1.0130* (0.4424)	0.7760* (0.3534)
Interaction Ind-prev	0.3996 (0.2451)	0.9618* (0.4560)	1.0861* (0.4508)	0.8662** (0.3353)
1.no_comp	0.5071* (0.2302)	0.5382* (0.2310)	0.4695* (0.2048)	0.4070 (0.2177)
2.no_comp	0.5101* (0.2285)	0.7827** (0.2735)	0.6862** (0.2398)	0.5622* (0.2467)
3.no_comp	0.4657 (0.2516)	0.8776* (0.3613)	0.8378** (0.3090)	0.6251* (0.2778)
4.no_comp	0.6434* (0.2925)	1.3346* (0.5193)	1.4127** (0.4578)	1.2240** (0.3875)
5.no_comp	1.3603*** (0.3095)	1.8367* (0.7494)	1.7625* (0.6768)	1.7752*** (0.5117)
ln_fix_line	0.3488*** (0.0739)	0.3449* (0.1613)	0.2488 (0.1386)	0.2273* (0.0972)
ln_urb_pop	0.3441 (0.2077)	0.7359 (1.6431)	0.7192 (1.4740)	0.4096 (0.2700)
ln_gdp_head	0.3069* (0.1221)	1.3001 (0.7251)	1.1103 (0.6532)	0.3584 (0.2060)
pol_risk	No	No	Controlled	Controlled
fin_risk	No	No	Controlled	Controlled
eco_risk	No	No	Controlled	Controlled
R^2 within	0.8932	0.9199	0.9293	0.9259
N	1012	1012	1012	1012

Notes: Robust standard errors in parentheses.
Model (1) is simple OLS Model. Model (2) is Fixed effect model, Model (3) is fixed-effect model including three macroeconomic risk variable, and Model (4) is Random effect model.
***significant at 1%; **significant at 5%; *significant at 10%

Table 6
Dynamic model estimation results

	Short run	Long run
Lag ln_mob_sub	0.8785*** (0.0202)	
Independent regulator	0.0551 (0.0670)	0.4535
Privatization	0.0777 (0.0927)	0.6395
Interaction Ind-priv	0.0357 (0.0675)	0.2938
1.no_comp	0.1273 (0.0725)	1.0477
2.no_comp	0.1260 (0.0815)	1.0370
3.no_comp	0.1393 (0.0753)	1.1465
4.no_comp	0.1914* (0.0757)	1.5753
5.no_comp	0.1477 (0.0826)	1.2156
ln_fix_line	-0.0012 (0.0128)	
ln_urb_pop	0.0708 (0.0432)	
ln_gdp_head	-0.0208 (0.0304)	
pol_risk	Controlled	
fin_risk	Controlled	
eco_risk	Controlled	
Arellano-Bond test for AR(1)	0.002	
Arellano-Bond test for AR(2)	0.480	
Hansen test of overid.	0.247	
Exogenity	0.106	
Number of instruments	44	
N	966	

Notes: Robust standard errors are in parentheses.
The long-run effects are calculated by dividing short run coefficients to convergence rate (1- 0.8785).
***significant at 1%; **significant at 5%; *significant at 10%

Table 7. Robustness check results (I)

	Model (3)	Model (5)	Model (6)
Independent regulator	0.3300 (0.2330)	0.3444 (0.2383)	0.2995 (0.2414)
Privatization	1.0130* (0.4424)	1.0768* (0.4436)	1.0370* (0.4149)
Interaction Ind-priv	1.0861* (0.4508)	1.1438* (0.4510)	1.0470* (0.4252)
1.no_comp	0.4695* (0.2048)	0.4742* (0.2046)	0.4747* (0.2010)
2.no_comp	0.6862** (0.2398)	0.6980** (0.2381)	0.6620** (0.2356)
3.no_comp	0.8378** (0.3090)	0.8590** (0.3019)	0.8034** (0.2985)
4.no_comp	1.4127** (0.4578)	1.4761** (0.4568)	1.3393** (0.4733)
5.no_comp	1.7625* (0.6768)	1.7961* (0.6818)	1.7198* (0.6799)
ln_fix_line	0.2488 (0.1386)	0.2519 (0.1381)	0.275 (0.1402)
ln_urb_pop	0.7192 (1.4740)	0.7568 (1.4942)	0.6862 (1.4598)
ln_gdp_head	1.1103 (0.6532)	1.0789 (0.6541)	1.0795 (0.6486)
Bureaucracy	–	Controlled	–
Corruption	–	–	Controlled
pol_risk	Controlled	–	–
fin_risk	Controlled	Controlled	Controlled
eco_risk	Controlled	Controlled	Controlled
R^2 within	0.9293	0.9295	0.9303
N	1012	1012	1012

Model (3): Main model, Model (5): Fixed effect model control for bureaucracy quality instead of political risk. Model (6): Fixed effect model control for corruption instead of political risk.

Table 8. Robustness check results (II)

	Model (3)	Model (7)	Model (8)
Independent regulator	0.3300 (0.2330)	0.9909 (0.7648)	0.8818 (0.5481)
Privatization	1.0130* (0.4424)	0.9850* (0.4177)	1.0502* (0.4016)
Interaction Ind-priv	1.0861* (0.4508)	1.7038 (0.8760)	1.6331* (0.6795)
1.no_comp	0.4695* (0.2048)	0.4441* (0.2060)	0.4608* (0.1988)
2.no_comp	0.6862** (0.2398)	0.6648** (0.2399)	0.6657** (0.2285)
3.no_comp	0.8378** (0.3090)	0.8140** (0.2977)	0.7823* (0.2958)
4.no_comp	1.4127** (0.4578)	1.4310** (0.4598)	1.3318** (0.4781)
5.no_comp	1.7625* (0.6768)	1.7314* (0.6890)	1.6878* (0.7026)
ln_fix_line	0.2488 (0.1386)	0.2562 (0.1380)	0.263 (0.1423)
ln_urb_pop	0.7192 (1.4740)	0.8976 (1.4514)	1.0041 (1.5125)
ln_gdp_head	1.1103 (0.6532)	1.0441 (0.6555)	1.0372 (0.6759)
int ind reg-corruption (0)	–	–	0.2917 (0.1550)
int ind reg-corruption (1)	–	–	0.0476 (0.1022)
int ind reg-bureaucracy (0)	–	0.3168 (0.2515)	–
int ind reg-bureaucracy (1)	–	-0.0174 (0.2329)	–
pol_risk	Controlled	Controlled	Controlled
fin_risk	Controlled	Controlled	Controlled
eco_risk	Controlled	Controlled	Controlled
R^2 within	0.9293	0.9300	0.9314
N	1012	1012	1012

Model (3): Main model, Model (7): Fixed effect model with control for interaction of independent regulator and bureaucracy quality. Model (8): Fixed effect model control for interaction of independent regulator and corruption.