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Impact of regulatory process on Telecom Firm Performance: Evidence from Non Parametric Approach

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Abstract

This paper analyzes the effects of regulation, privatization and competition on the telecommunications performance in 40 Latin American, African and Arab countries from 1992 through 2010. By using difference-in-Difference with control variables and propensity score matching techniques, our study reveals that regulation is positively correlated with tariffs and quality. However; competition has no effect on tariffs. This result allows us to suspect the presence of collusion between competitors.

Keywords: Reglementation; firm performance; propensity score matching; difference-in-differences.

1. Introduction

In the past two decades, regulation, competition and privatization have been considered as key elements of telecommunication reform process in developing countries. The main reason to establish a regulatory authority is because the opening of telecommunication sector to competition Souam and Pénard (2002). However, the transition from monopolies to competitive markets, there was needed independent regulation to stimulate competition, to protect user interests and encourage the privatization of incumbent operator Hubert (2004) and Shelanski (2006). Studies conducted by the International Telecommunications Union, shows that countries that have achieved better performance in the telecommunications in terms of quality , prices and services are the first who adopt this regulatory process.

In this context the econometric studies to date consist largely to quantify the impact of indicators of reform on telecom performance. These econometric studies have provided important insights into reforms efforts, but presented some econometric gaps using quite dummy variables (0,1). In fact, when we use dummy variable corresponding to one of the indicators of reform: Privatization, Regulation or competition, we are faced with two groups; one group benefit from the presence of a regulatorR=1 and another group that does not benefit from the presence of a regulator R=0. The net effect of regulation on performance is ambiguous. If we do not take into account this ambiguity, which is similar to a self-selection, it may produce biased estimates Abadie (2005). To correct selection bias, statisticians have invented a new econometric method namely; econometric evaluation methods or "Matching Model."

Our work is in this context and in which, we will explore the impact of regulation, privatization and competition on the both mobile and fixed phone performance in terms of quality, interconnection fees and subscription levels, using the technique DID differences-in-differences (Heckman and al. 1997; Meyer 1995). Our econometric study will involve a sample of 40 countries from 1992 to 2008. This method is an extension of the econometric evaluation technique.

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In following sections, we start with the presentation of comparative analysis of telecom reform policy and testable hypothesis. Then, we discuss the modeling framework. The data are described in the next section. Then, the statistical procedures to test for differences in performance are discussed and followed by the presentation and discussion of the empirical results. Finally, in conclusion, the possible extensions and limitations of the present study are presented.

2. Background and Telecom Reform

2.1. Comparative analysis of telecom reform policy

At present, more than 80 per cent of countries have a telecommunication regulatory authority. In Arab world 16 countries have a regulatory authority, and 15 authorities were created after 2000. In contrast, Some Latin American countries, Argentina, Brazil and Colombia, for instance undertook the first regulatory separation in the 1980s. Despite this progress, several Arab countries are still in the early stages of telecommunication reform compared to such counterparts in Europe and Latin America. In fact, six countries in the Arab States region (Djibouti, Kuwait, Syria, Somalia, Yemen, the Palestinian Authority and Libya) have not established their Regulation authority before 2009. In Egypt, Algeria and Morocco the authority is responsible for all Aspects relating to licensing, numbering, interconnection, universal service, radio Spectrum. In contrast, the role of the regulator authority in Tunisia is limited. Compared to Arab authorities, the rise of independent regulatory agencies of Latin America is a common characteristic after the privatization process.

The experience of privatization in Arab countries is still in the early stage compared to Latin America and Europe. Telecommunications reform across Latin America has pushed privatization more than in other regions of the world. After British Telecom in the United Kingdom privatized, the first telecom operator in the western capitalist economies to do so, Latin American countries followed suit. Chile s initiatives served as important model, but the way privatization took place was different across countries and deserves further study and analysis. In general context, competition and encourage privatization. This role differs from one region to another and from one country to another. This is closely related to the date of creation and to the independence of each agency of government pressure from the dominant operators, and seeks to maximize the utility of all market players (Table 1).

Table 1. Different scenarios of regulators

Scenarios of regulation	Countries
Regulatory responsibilities within the ministry	Japan, China
A fully autonomous independent regulator	United kingdom , Germany, Argentina
A semi autonomous independent regulator	Tunisia, Canada
Industry self regulation	Some developing countries
No telecommunication specific regulation	New Zealand, Djibouti, Kuwait, Syria

2.2. Motivation of telecom reform and testable hypothesis

Our goal is to find a theoretical relationship between indicators of reform namely; regulation, privatization and competition and telecom performance in terms of service quality, tariffs, as well as the interaction between them. In this section, we will present empirical literature in order to derive our testable hypotheses.

Do indicators of reform improve firm performance?

The effect of three indicators of reforms on telecom performance differs across empirical studies and in variety of contexts.

Wallsten, S. (2003) use a sample of *200 countries of fort regions (Africa*, Asia, Europe and Latin America): he show that regulation and competition has a positive effect on per capita number of mainlines, payphones, and connection

capacity, and with decreases in the price of local calls. This study also suggests that the effect of privatization is positively correlated with telecom performance. Ahmed Ezzat, R. (2017), use the IV-2SLS econometric estimation and he find that institutional, political and economic variables matter and affect telecom reforms, which in turn affect telecom performance. Thus, we propose the following hypothesis:

Hypothesis 1: A positive effect exists between the creations a regulatory authority, competition and privatization on telecom performance.

When they are combined with the index of independence, the three indicators express a higher effect on telecom performance. Debbichi, S. (2015), studied the interaction effect between three indicators on the mobile market performance with the literature through the interaction effect Model, among the panel data analysis methods. He use a sample of 18 Arab countries and he found remarkable positive effect on performance when done estimate both competition and privatization with the regulation and independency.

Hypothesis 2: A positive effect exists between the creations an independent regulatory authority and the two indicators of reform (competition and privatization).

The goal of creation of regulatory authority is to stimulate competition by prevention new entrants from anticompetitive behavior and encourage privatization. The last is defined as the deliberate sale of state-owned enterprises to private economic agents My Tran, N and al. (2015). The privatization can be a test of independence of the regulator. In fact, if the incumbent is privatized more pressure on the regulator decreases and more independence is strengthened, Levine and al. (2002). In addition, the aim of the regulator is to strengthen its independence. Hence, we expect that:

Hypothesis 3: The privatizing process is clearly the essential key of independence of the regulatory authority.

3. Methodology and Previous Studies

The performance of firms is studied across a variety of econometric modeling. The use of propensity score matching has in recent years experienced a significant achievement for estimating the effects of public interventions in health, education and employment[†]. This method enriches the existing literature and corrects the inefficiency of some results and selection bias due to the use of dummy variables used in the works cited above. It involves comparing the performance of two groups who receive treatment and those who do not benefit. My Tran, N and al. (2015) analyzes the effects of privatization on the performance of firms switching their ownership from state-owned to private-owned ownership. The result is that privatization is an efficient way to improve the financial performance of Vietnamese state-owned enterprises. Indeed, Chaouani (2010) used econometric evaluation approach and propensity score based on a unique firm-level panel data set of more than 3950 French firms from several industries. This approach is to measure the effect of treatment of public structure (Treated) and private (non-treated) on the firm's performance. The results shows that choose to be public coincide with a higher level of performance. In other context, Monteiro, N-P. (2010), evaluated the impact of privatization on wage, using propensity matching estimators. The results show a negative (positive) short-run (long-run) effect of privatization on relative wage growth for both men and women retained in the privatized firms. Johan A.P, and Heinrich V.T (2009) applies a semi –parametric propensity score matching approach to evaluate the effects of agri- environment programmers on input use and farm output of individual farms in Germany. Jiahuan Lu (2015) employs a quasi-experimental design to evaluate the effectiveness of performance-based contracting (PBC) for individual employment outcomes over the (2004-2009) period, with the Michigan vocational rehabilitation program as a control using *propensity score matching* and *difference-in-differences* regressions to control for the imbalances between the two states. The result finds that (PBC) significantly improves employment result and reduces time to employment, two measured performance indicators.

[†] *Statistics (Holland 1986; Rubin 2006, 1974; Rosenbaum 2002), economics (Abadie and Imbens 2006; Galiani, and al.2005; Dehejia and Wahba 2002, 1999), medicine (Christakis and Iwashyna 2003; Rubin 1997), sociology (Morgan and Harding 2006; Diprete and Engelhardt 2004; Winship and Morgan 1999; Smith 1997) political science (Bowers and Hansen 2005; Imai 2005; Sekhon 2004b), and even law (Rubin 2001)*

4. Empirical Methodology

4.1. Data, variables measurement and descriptive statistics

In order to find consistent results, the sample ranges 40 countries with homogeneous characteristics (Arab World, Europe and Latin America) from 1992 to 2011. Furthermore, data are available annually from ITU (International Telecommunication Union). Our econometric estimation ranges three types of variables, outcomes' variables, treatment variables and control variables. These variables can be cited as follows: The outcome variables are the termination rates in fixed and mobile phone and quality of service, it can be considered as a variable that reflects the performance of the both sector. (MTR): Prices of mobile communication as measured by the call cost per three minutes (MT/3mn) in U.S. Dollar is expressed in logarithm. (FTR): Price of fixed communication measured by the call cost per three minutes (FT/3mn) in U.S. Dollar and expressed in logarithm. (Faults): number of connection error or failure to call 100 mainlines. This is a variable of the quality of fixed service phone. The treatment variables are three: (Regulation**)**: This is a dummy variable that takes the value 1 from the year he has been creating a regulatory agency "separate" from ministry. (Competition**)**: The number of mobile operators other incumbent who installed their networks and sell their services. **(**Privatization**)**: This is a dummy variable that takes the value 1 from the year in which there has been privatization of the incumbent and 0 otherwise. While another group arranges the control variables **(**GDP / capita**)**, expressed in U.S. Dollar **(**urban**),** and (total population**)** .These macroeconomic variables denote the demand factors in the both sector. (TLPSE**):** Total capacity of local public switching exchanges (total exchange capacity of the service provider for fixed number). (RMT)**:** Residential telephone monthly subscription in US Dollar. (MCM**):** Mobile cellular subscription in US Dollar. (MCC**):** Mobile connection charge in US Dollar.

Table 2. Descriptive statistics of treatment variables

		Overall		Between		within
		Frequency	Percent	Frequency	Percent	Percent
Regulation (n = 41)	Control	228	38.32	18	43.90	66.67
	Treated	367	61.68	37	90.24	78.38
	Total	595	100.00	55	134.15	74.55
Privatisation (n = 41)	Control	395	66.72	30	73.17	85.06
	Treated	197	33.28	18	43.90	86.01
	Total	592	100.00	48	117.07	85.42
Competition. Fixed phone (n = 41)	Control	408	68.57	26	63.41	92.60
	Treated	187	31.43	18	43.90	94.02
	Total	595	100.00	44	107.32	93.18
Competition. Mobile phone	Control	465	78.15	34	82.93	87.52
	Treated	130	21.85	17	41.46	66.14
	Total	595	100.00	51	124.39	80.39

Table 3. Table of covariates statistics

		Mean	Std.Dev	Min	Max	Obs.
Population	Overall	2.73e+07	4.62e+07	467428	3.09e+08	N = 595
	Between		5.19e+07	631890.3	2.93e+08	n = 41
	Within		2275459	1.27e+07	4.31e+07	T-bar =14.51
Urban population	Overall	67.40314	20.51087	11	99	N = 573
	Between		18.35664	27.15789	97.63158	n = 39
	Within		5.843615	41.45577	103.4558	T-bar =14.69
TLPSE	Overall	1148277	2001394	7656	1.37e+07	N = 342
	Between		1709549	15572.37	7390810	n = 18
	Within		1112336	-4140678	7489616	T = 19
MCC	Overall	100.3547	215.6468	2	2082	N = 499
	Between		103.6306	4	373.1333	n = 41
	Within		186.288	-255.7786	1841.178	T-bar = 12.17
RMT	Overall	10.30588	7.280379	1	33	N = 595
	Between		6.430353	1.105263	24.54545	n = 41
	Within		3.713156	-1.694118	33.41115	T-bar = 14.51
MCM	Overall	19.23577	19.94395	0	209	N = 492
	Between		13.34055	5.181818	74.33333	n = 39
	Within		15.87819	-52.09756	153.9024	T-bar = 12.61
GDP	Overall	283.3496	161.6196	1	566	N = 595
	Between		98.78821	106.3158	470.3636	n = 41
	Within		129.9259	-120.8083	682.4405	T-bar = 14.51

4.2. Neyman-Rubin Causal Model

To evaluate the impact of regulation, privatization and competition on the telecommunication performance, requires making an inference about the performance that would have been observed in the absence of the creation of a regulatory authority. As we cannot observe the performance of the sector of mobile phone in the case or control had not occurred, or before it is created, the establishment of causal inference becomes a problem with a lack of data. The Causal Model was introduced by Rubin (1974).

More specifically, the Rubin model based on the existence of two latent variables of outcome. LetY_{i1} denote the potential outcome for country i if the unit receives treatment $D_i = 1$ (regulation or privatization), and let Y_{i0} denote the potential outcome for country i in the control regime $D_i = 0$. The treatment effect for observation $i$is defined by $\Delta_i = Y_{i1} - Y_{i0}$ Causal inference is a missing data problem because Y_{i1} and $Y_{i0}$are never both observed. Thus for a country i that has established a regulatory authority, Y_{i1} is observed, Y_{i0} while is unknown. The same thing for a country i that has not established a regulatory authority Y_{i0} is observed while Y_{i1} is unknown. The fact remains that we cannot observe both potential outcomes at the same time. For a country "untreated" Y_{i0} is known the result

Counter-factual. Finally, the observed outcome variable (performance) can be deduced from the potential variables and the variable "treatment "by the relation:

$$\mathrm{Y_i} = \mathrm{Y_{i0}} + \mathrm{D_i}(\mathrm{Y_{i1}} - \mathrm{Y_{i0}}) \tag{1}$$

For each country only torque (Y_i, D_i) is observed.

The causal effect is done by the following equation:

$$\Delta_\mathrm{i} = \mathrm{Y_{i1}} - \mathrm{Y_{i0}} \tag{2}$$

Δ_i : The difference between the performance of telecommunication sector in country i with presence of regulatory authority and the performance of the sector in absence of regulation. This causal effect is unobservable, since only one of the two potential variables is observed for each individual. It is also individual, and thus there is a distribution of the causal effect in the population studied. Finally, let X_i denote the control variables for each country i that will be exposed later.

Since the causal effect is unobservable, it is also not identifiable. In contrast, with assumptions about the joint distribution of the triplet $(Y_{i1}, Y_{i0}, D_i,)$, we can identify some parameters of the distribution of the causal effect from the density of the observable variables (Y_i, D_i). Two parameters are identifiable:

1) The average treatment effect (ATE) can be estimated:

$$\Delta^{\mathrm{ATE}} = \mathrm{E}(\mathrm{Y_{i1}} - \mathrm{Y_{i0}}) \tag{3}$$

2) The average treatment effect in the population of treated countries:

$$\Delta^{\mathrm{ATT}} = \mathrm{E}(\mathrm{Y_{i1}} - \mathrm{Y_{i0}}/\mathrm{D_i} = 1, \mathrm{X_i}) \tag{4}$$

So that, $\Delta^{ATE} = \Delta^{ATT}$ should that the outcome variables are independent of the treatment variable, i.e. if $(Y_{i1}, Y_{i0}) \coprod D_i$, it is possible to identify the two parameters of interest Δ^{ATE} and Δ^{ATT}.

$$\begin{aligned}\Delta^{\mathrm{ATE}} &= \mathrm{E}(\mathrm{Y_{i1}}) - \mathrm{E}(\mathrm{Y_{i0}}) = \mathrm{E}(\mathrm{Y_{i1}}/\mathrm{D_i} = 1) - \mathrm{E}(\mathrm{Y_{i0}}/\mathrm{D_i} = 0) \\ &= \mathrm{E}(\mathrm{Y_i}/\mathrm{D_i} = 1) - \mathrm{E}(\mathrm{Y_i}/\mathrm{D_i} = 0)\end{aligned} \tag{5}$$

And

$$\begin{aligned}\Delta^{\mathrm{ATT}} &= \mathrm{E}(\mathrm{Y_{i1}}/\mathrm{D_i} = 1,) - \mathrm{E}(\mathrm{Y_{i0}}/\mathrm{D_i} = 1,) = \mathrm{E}(\mathrm{Y_{i1}}/\mathrm{D_i} = 1,) - \mathrm{E}(\mathrm{Y_{i0}}/\mathrm{D_i} = 0,) \\ &= \mathrm{E}(\mathrm{Y_i}/\mathrm{D_i} = 1) - \mathrm{E}(\mathrm{Y_i}/\mathrm{D_i} = 0)\end{aligned} \tag{6}$$

In this case, we obtain, $\Delta^{ATE} = \Delta^{ATT}$, that can be estimated by the difference of average variables results in the treated and untreated group. It may be noted that the identification of the second parameter requires a weaker assumption. In this case, it is sufficient that $Y_{i0} \coprod D_i$. Suppose now that the condition of independence is not satisfied previous, the natural estimator formed by the difference in means of the outcome variables is affected by a *selection bias*. In fact,

$$\begin{aligned}\mathrm{E}(\mathrm{Y_i}/\mathrm{D_i} = 1) - \mathrm{E}(\mathrm{Y_i}/\mathrm{D_i} = 0) &= \mathrm{E}(\mathrm{Y_{i1}}/\mathrm{D_i} = 1,) - \mathrm{E}(\mathrm{Y_{i0}}/\mathrm{D_i} = 0,) \\ &= \mathrm{E}(\mathrm{Y_{i1}}/\mathrm{D_i} = 1,) - \mathrm{E}(\mathrm{Y_{i0}}/\mathrm{D_i} = 1) + \mathrm{E}(\mathrm{Y_{i0}}/\mathrm{D_i} = 1) - \mathrm{E}(\mathrm{Y_{i0}}/\mathrm{D_i} = 0) \quad (7) \\ &= \Delta^{\mathrm{ATT}} + \Delta^{\mathrm{BTT}} \quad (8)\end{aligned}$$

with;

$\Delta^{\mathrm{BTT}} = \mathrm{E}(\mathrm{Y_{i0}}/\mathrm{D_i} = 1) - \mathrm{E}(\mathrm{Y_{i0}}/\mathrm{D_i} = 0)$: The selection bias. This bias can be explained by the fact that the average situation of countries which have received treatment (regulator creation) is not the same countries that do not benefit. And also because the two population groups are not identical (Treated and untreated) this has been studied by My Tran and al. (2015).

Several solutions are implemented by researchers to fight against this selection bias Brodaty, and al. (2008). The principle of social experiments and the matching method are the best known Rajeev H. and al. (2006). The first is to assign randomly countries potentially interested in a regulation, a privatization reform etc. A treatment group that will benefit from the reform program or a group of control that will not benefit. While the second is to develop a propensity score. This score measures the probability of access to the treatment program for each individual, beneficial or not, and independently of program (regulation) results. Other two methods do not have these characteristics and are based on the analysis of results such as: regression discontinuity and differences-in-differences (DID) method are all outlined in the following.

4.3. Difference in difference model

The method of DID is deducted from the part of individual fixed effects models and time, used in panel data method My Tran, N and al. (2015). The general form of the model is as follows:

$$\mathrm{Y_{it}} = \alpha \mathrm{D_{it}} + \beta_{\mathrm{i}} + \gamma_{\mathrm{t}} + \varepsilon_{\mathrm{it}}; \mathrm{i} = 1..\mathrm{Net\ t} = 1 \ldots\ldots, \mathrm{T} \quad (9)$$

Where

Y_{it}: The outcome variable (Performance) for country $i$at time$t$.

D_{it} : is the dummy treatment (control) for country i at time t.

$$D_{it} = \begin{cases} 1\ if\ treated \\ 0\ if\ not \end{cases}$$

α:Is a parameter to be estimated, which represents the effect of the treatment (here assumed constant)

β_i : Individual fixed effect.

γ_t: Common time effect to all countries.

The terms, D_{it}, β_i and $\gamma_t$are potentially correlated, then $\varepsilon_{it}$is a random centered, homoscedastic, and uncorrelated toD_{it} ,β_i et γ_t.

We then face two groups: One group of countries on treated (presence of regulator: $D_{it} = 1$ from a time t = τ, and a second control group for non-treated (absence of regulator: $D_{it} = 0$) at t <τ. The same for the other dummy variables relating to privatization and competition.

The idea is to eliminate the fixed effects by first difference and time effects by a second difference Abadie, A. (2005):

$$\Delta \mathrm{Y_{it}} = \alpha \Delta \mathrm{D_{it}} + \Delta \gamma_{\mathrm{t}} + \Delta \varepsilon_{\mathrm{it}}; \mathrm{i} = 1..\mathrm{Net\ t} = 1 \ldots\ldots, \mathrm{T} \quad (10)$$

where

$$\Delta \mathrm{Y_{it}} = \mathrm{Y_{it}} - \mathrm{Y_{it-1}}\ ; \Delta \gamma_{\mathrm{t}} = \gamma_{\mathrm{t}} - \gamma_{\mathrm{t-1}}\ ; \Delta \varepsilon_{\mathrm{it}} = \varepsilon_{\mathrm{it}} - \varepsilon_{\mathrm{it-1}} \quad (11)$$

Now if we put $t = \tau$ and $t - 1 = \tau - 1$ (or $t \geq \tau$ and$t - 1 \leq \tau - 1$)

If i ∈ **Treatment**, then: $\Delta \mathrm{D_{it}} = 1$ which implies that $\Delta \mathrm{Y_{it}^{Tr}} = \propto + \Delta \gamma_{\mathrm{t}}^{\mathrm{Tr}} + \Delta \varepsilon_{\mathrm{it}}^{\mathrm{Tr}}$

If i ∈ **Control ,** $\Delta \mathrm{D_{it}} = 0$ which implies that $\Delta Y_{it}^{C} = \Delta \gamma_t^C + \Delta \varepsilon_{it}^C$.

The second difference eliminates common time effects.

$$\propto = E(\Delta Y_{it}^{Tr}) - E(\Delta Y_{it}^{C}) \quad (12)$$

Since, $\Delta \gamma_t^{Tr} = \Delta \gamma_t^C$ and $E(\Delta Y_{it}^{Tr}) = E(\Delta Y_{it}^{C}) = 0$ (13)

The DID estimator is then given by:

$$\hat{\alpha} = \left(\Delta\overline{Y_{i\tau}^{Tr}}\right) - \left(\Delta\overline{Y_{i\tau}^{C}}\right) \quad (14)$$

$$\text{With } \left(\Delta\overline{Y_{it}^{k}}\right) = \frac{1}{N_k}\sum_{i=1}^{N_k}\left(Y_{i\tau}^{k} - Y_{i\tau-1}^{k}\right), k \in \{Tr, C\} \quad (15)$$

In a multiple regression model it becomes:

$$Y_{it} = \alpha D_{it} + \mu Z_{it} + \beta_i + \gamma_t + \varepsilon_{it}; i = 1..\text{Net } t = 1 \ldots..., T \quad (16)$$

The estimator of the DID is equivalent to the estimator "within" the projected pattern on the space orthogonal to the fixed effects and time Hsiao, C. (2003).

$$WY = WX\beta + W\varepsilon \quad (17)$$

Where$X_{it} = [D_{it}, Z_{it}]$ and $= (\alpha, \acute{\mu})$. The estimator "within" of the parameter vector is given by:

$$\hat{\beta}_{cov} = \left(\acute{X}\, WX\right)^{-1}\left(\acute{X}\, WY\right) \quad (18)$$

$$V\left(\hat{\beta}_{cov}\right) = \sigma^2\left(\acute{X}\, WX\right)^{-1} \quad (19)$$

Assumptions of the implementation of the DID estimator are four and are:

$\boldsymbol{H_1}$: The temporal effects are assumed to be common to the both treatment groups and the control group $\gamma_t^{Tr} = \gamma_t^C$, at least $t = \tau$ and$t - 1 = \tau - 1$.

$\boldsymbol{H_2}$ **:** There can be no attrition or endogenous selection between $\tau - 1$ and τ.

$\boldsymbol{H_3}$ **:** The error terms are assumed not auto correlated; otherwise, the standard deviation of the treatment effect is systematically underestimated Bertrand, M. and al. (2004). In this case, the null hypothesis of no treatment effect $H_0: \alpha = 0$ is rejected too.

5. Results and Discussion

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The difference–in-difference method measures the difference in an outcome (performance in terms of Tariffs and quality) between the treatment and control groups over the period (1992-2008):

1/The first difference should eliminate individual systematic effects;

2/The second difference should eliminate eliminates time effects (common to both groups) in the absence of the program.

This estimator is used to identify the causal effect, causal, measurement needs to be evaluated under the assumption that the performance of the two groups would have actually evolved in the same way in the absence of regulation.

For example, with the treatment variable "Privatization" we are faced with two situations. The presence of two groups: one affected by a privatization program (treated group) and the other no-affected (control group). And two other groups (before and after) starting privatization program. Both situations are summarized in the table 6.

The specific causal effect of privatization on interconnection rates for mobile phone (IMR) is positive and equal to 0,026. This score is obtained by the following double difference:

$Difference - in - difference = Impact\ of\ privatisation \quad = (MTR_{t1} - MTR_{t0}) - (MTR_{C1} - MTR_{C0})$

or: $Difference - in - difference = Impact\ of\ privatisation = (MTR_{t1} - MTR_{C1}) - (MTR_{to} - MTR_{C0})$ (20)

With $MTR_{t1,}MTR_{t0}, MTR_{C1}andMTR_{C0}$, are, respectively, the performance of the sector (in terms of prices); for the treatment group before and after starting the privatization program and the comparison group before and after starting program. The statistic results show that no significant difference between treated and untreated group.

The estimation results are as follows: regulation has a negative effect on the interconnection rates of mobile and fixed networks, but negative on the level of service quality. While privatization has a positive effect only on the interconnection tariffs of mobile phones and a negative effect on the other two performance variables. However, competition has no effect on tariffs. This result allows us to suspect the presence of collusion between competitors. Indeed, they cooperate on the wholesale market to maintain high retail prices. This result has been widely studied Debbichi, S., and Ben khalifa, A. (2013).

Table 6. Causal effect of privatization on mobile termination rate

	Treated group		*Untreated group*		*Difference*
After privatisation program	9685.007	-	9723.879	⇒	(-38,872)
	-		-		-
Before privatisation program	9680.169	-	9719.067	⇒	(-38,898)
	=		=		⇓
Difference	4,838	-	4,812	⇒	=0.026

6. Concluding Remarks

In this paper we was explored the impact of regulation; privatization and competition on the both mobile and fixed phone performance, in terms of service quality (network faults) and tariffs in both fix and mobile telecommunication services, using the technique of propensity score matching (non parametric approach) and based on panel data Difference-in-Differences estimations from 1990 to 2008.. Overall, our estimations show a positive relationship between the presence of regulator and tariffs and quality. However, competition has no effect on tariffs. This result allows us to suspect the presence of collusion between competitors. The results of estimation model are generally consistent with various hypotheses in economic theories of regulation. Indeed, the establishment of a regulatory authority is a critical component in reforming sector of mobile phone. Indeed, we found a strong positive correlation between regulation and two indicators of mobile performance. Several variables can be introduced to correct the inefficiency of the estimate, such as those relating to the characteristics of regulation (price caps, cost of service...) of performance (number of employees, organization, financial resources), and privatized share of each operator. We can also introduce a variable that indicates whether the establishment of regulatory authority before privatization or the introduction of this variable may help us to evaluate the effort of regulatory authorities in the privatization of incumbent operators and its impact on performance sector.

This study contributes in existing literature by overcoming methodological shortcomings of previous studies on the effect of regulation competition and privatization on performance of telecommunication firms and correction of the inefficiency of some results and selection bias due to the use of dummy variables, such as no control for selection biases due to non-random drawn characteristics of regulated sample and inadequate control for concurrent effects of other economic factors.

The matching estimation, moreover DID method, it ranks various types of estimators namely the matching estimator stratified, Stratification Matching and the nearest neighbor (Nearest Neighbor Matching Morgan and Harding 2006; by matching with Beyer, K. and al.1999) by matching a given threshold (Caliper Matching) by matching a given radius (Radius matching) by matching with kernel (Kernel matching, M.Villa J.(2016)) and exact matching with group (coarsened exact matching): purpose of futures scientific productions

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Table 4. Descriptive statistics of outcomes' variables

			Mobile phone fees					Fixed phone fees					Quality of service				
			Mean	Std.Dev	Min	Max	Obs.	Mean	Std.Dev	Min	Max	Obs.	Mean	Std.Dev	Min	Max	Obs.
Privatization	Control	Overall	124.977	74.70	1	269	316						36.8	57.9	0	327	376
		Between		64.17	19.52	247.8	26							55.1	0	220.4	29
		Within		41.17	-16.02	293.7	12.1							19.06	-44.5	178.1	12.9
	Treated	Overall	155.37	65.096	11	274	185						20.4	30.4	0	136	197
		Between		60.10	57.5	267	18							29.5	0	125.5	18
		Within		30.46	53.91	250.1	10.2							14.03	-20.9	100.5	10.94
Regulation	Control	Overall	116.1	73.4	1	274	143	93.3	70.46	1	230	228	61.9	64.4	0	327	211
		Between		69.47	22.4	267	15		63.27	1	218.6	18		62.3	0.64	216	17
		Within		40.13	0.56	276.9	9.53		20.53	39.3	162.3	12.6		22.3	-15.0	203.9	12.41
	Treated	Overall	144.2	70.98	3	267	358	131.5	55.3	1	233	345	14.7	32.09	0	230	365
		Between		65.85	4.2	247.8	36		57.4	1	215.3	35		38.2	0	230	36
		Within		35.17	3.21	241.2	9.94		20.4	62.95	273.1	9.85		10.8	-27.4	94.8	10.1
Competition F	Control	Overall						100.3	65.8	1	233	408					
		Between							59.15	1	218.6	26					
		Within							23.75	33.7	251.07	15.69					
	Treated	Overall						155.8	39.2	59	232	165					
		Between							36.8	91.9	215.3	16					
		Within							16.4	115	228.4	10.31					
Competition M	Control	Overall	140.5	74.3	1	274	371						39.2	56.4	0	327	446
		Between		67.8	19.6	267	33							45.9	0	220.4	33
		Within		38.9	-0.47	303.5	11.24							25.1	-60.7	260.2	13.51
	Treated	Overall	123.8	66.6	11	267	130						7.27	14.19	0	74	130
		Between		71.9	17	245.9	17							11.7	0	44.5	17
		Within		31.36	36.7	184.7	7.64							7.78	-32.2	36.7	7.64

Table 5. Estimation results of Difference-difference method

	Treatment variables								
	Regulation			Privatisation			Competition		
variables	Mobile.T.R	Fixed.T.R	Quality	Mobile.T.R	Fixed.T.R	Quality	Mobile.T.R	Fixed.T.R	Quality
GDP	7349.987	2.4e+04	2.1e+04	-1.0e+04	9895.966	1.9e+04	-1.2e+03	2.2e+04	2.0e+04
Population	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Urb. population	0.889	-0.242	0.370	1.099	-0.140	0.412	1.056	-0.220	0.405
TLPSE	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
RMT	1.976	1.890	1.893	1.673	1.273	1.757	2.334	1.246	2.095
M.C.M.S	0.591	0.690	0.176	0.182	0.432	0.081	0.443	0.643	0.141
M.C.C	-0.080	-0.016	-0.007	-0.068	-0.006	-0.003	-0.081	-0.017	-0.007

Table 6 (Continued). Estimation results of Difference-difference method

	Treatment variables													
	Regulation							Privatisation						
	Base line			Follow-up				Base line			Follow-up			
(Performance)	Control	Treatment	Différence (BL)	Control	Treatment	Difference(FU)	D.Différence	Control	Treatment	Difference (BL)	Contrôle	Treatment	Difference(FU)	D.Différence
Mobile.T.R	-7.8e+03	1.7e+04	2.5e+04	-7.8e+03	1.7e+04	2.5e+04	-12.574	9685.00	9723.87	38.872	9680.16	9719.067	38.898	0.026
Fixed.T.R	-1.0e+04	-284.633	9857.275	-1.0e+04	-284.447	9852.357	-4.918	-1.5e+03	1250.07	2721.350	-1.5e+03	1249.526	2720.034	-1.315
Quality	1567.339	7102.003	5534.665	1566.54	7098.446	5531.897	-2.767	6085.33	7751.48	1666.153	6082.28	7747.613	1665.333	-0.819

	Competition						
	Base line			Follow-up			
(Performance)	Control	Treatment	Différence (BL)	Control	Treatment	Différence (FU)	D.Différence
Mobile.T.R	988.136	-2.5e+03	-3.5e+03	987.652	-2.5e+03	-3.5e+03	1.709
Fixed.T.R	-7.9e+03	-252.317	7623.321	-7.9e+03	-252.116	7619.549	3.772
Quality	4166.59	4566.257	399.666	4164.499	4563.958	399.459	-0.208