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IMPACT OF TELECOMMUNICATIONS MARKET LIBERALIZATION ON LABOR PRODUCTIVITY IN ECONOMIC COMMUNITY OF WEST AFRICAN STATES

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ABSTRACT

This research establishes an indirect link between the liberalization of telecommunications services and labor productivity based on the causal chain following Francois (2002) and Wang (2006). Estimates are based on Economic Community of West African States (ECOWAS) countries data for the period of 2002-2012. The results show that the degree of competition has a significant effect on the performance of telecom services, which in turn significantly affects the labor productivity. There is no correlation between the openness of telecom services and the degree of competition. As policy implication, on the basis of our results, the regulation in the telecommunications sector needs to be strengthened in order to reduce operators' monopoly power. Thus, we will witness a great penetration of telecommunications services in the ECOWAS countries. In doing so the goal of universal service access would be achieved and the productivity of the work factor will improve accelerating economic growth.

Contribution/Originality: This study is one of very few studies which have investigated the impact the liberalization of trade in telecommunications services in African economies. Unlike other studies that analyze the impact on the growth economy, this article analyzes the impact of the liberalization of the sector on labor productivity in the ECOWAS zone.

1. INTRODUCTION

Telecommunication means any transmission, emission or reception of signs, signals, writings, images, sounds or information of any kind, whether by wire, mediums, optical or other electromagnetic system. This sector includes fixed telephony, mobile telephony, the Internet... The development of this sector is an asset for a country's economic growth since it improves the labor productivity and creates added value for firms. In the last two decades, the implementation of trade liberalization policies failed to stimulate global economic performance in most developing countries. This is particularly the case for African countries, which remain marginalized in international trade. The African and the Middle East region represented only 4.4 percent in 2004 in the telecom sector against 54.2% in Europe (Mezouaghi, 2006).

The recent literature identifies the poor quality and inadequacy of services as the main factors explaining the marginalization of Africa. The Trade policies regarding Africa services sector have been characterized by several institutional rigidities. This includes a strong regulation, a perpetual presence of natural monopolies and a strong discrimination in services sectors such as telecommunications, electricity, transport and finance. These factors lead

to high costs, affecting the competitiveness and productivity of the whole economy. Eifert (2005) using data from parity purchasing power (PPP), confirmed that Africa has relatively high costs compared to its levels of income and productivity. Collier and Gunning (1999) consider the transaction costs as major obstacles to economic growth in Africa.

Most reforms in African service sector gave rather mixed results. Only reforms in telecommunications sector were conclusive, especially with the growth of telephony and mobile markets. While until 1995, there were less than ten million users of mobile phones in Africa. It rose to 438 million in 2011 including 188 million in Africa. As for fixed telephony, it changes from 10 million in 2005 to 11 million in 2011. The ITU (2004) estimated that the telecommunications operators in Africa achieved in 2003 more than 10 billion dollars in revenue and about a billion dollars of profit.

The need for trade liberalization in services has emerged in a context of recognition of the dynamism of this sector. This led to the signing of the General Agreement on trade in Services (GATS) in 1994. The reforms in the service sector were mostly motivated by five main reasons: (i) technological innovations have promoted the competition in services infrastructure; (ii) the globalization of production and market system increased regulation costs, (iii) there was new knowledge in the economy of the regulation; (iv) there was a desire to improve the efficiency of the sector, (v) the existing regulations were inadequate for the new products. Moreover, we remember that the increasing competition between service providers in developed countries created profit opportunities (or demand) in developing countries. This steered the consolidation of the liberalization in the services sector through multilateral trade negotiations in the Uruguay.

The objectives of the liberalization of the telecom sector are as follows. It aspires to (i) enhance the development of existing services, (ii) increase the supply of new services and new facilities, (iii) boost services and public sector competition, (iv) attract private investment in the sector, (v) create new opportunities for the international expansion of the economies concerned, (vi) enhance economic growth and (vii) reduce the external deficit of the transactions in telecommunications (Intven and Tetrault, 2000). The liberalization in the telecom sector arises some crucial questions: What are the effects of this liberalization on economic growth and labor productivity for ECOWAS countries? How does the penetration of mobile phone, fixed phone and Internet enhance the productivity of work in these countries?

Few researches focus on service trade liberalization impact on productivity and results seem to be mitigated. Topalova and Khandelwal (2011) examines the effects of India's trade reforms in the early 1990s on firm productivity in the manufacturing sector, and find that these reforms do not appear to influence the effect of trade liberalization on firm productivity. While, Shepotylo and Vakhitov (2015) find that services liberalization influence TFP through the investment channel leads to even higher effect, Arnold *et al.* (2015) find positive effects on the productivity of manufacturing firms. These studies at micro level do not analyze the impact of trade liberalization in telecommunication sector on labor productivity.

Unlike the earlier work, this article addresses the issue of liberalization in the telecom sector in the ECOWAS region, which is now a fully customs union. Moreover, while previous research dealt with the impact of telecommunications liberalization on economic growth and on firm productivity, this article analyzes if the liberalization enhances the labor productivity. Another value added of this article is the use of simultaneous equations and the triple squares method (3SLS). The methodological approach relies on both statistical and econometric analysis. Following Francois (2002) and Wang (2006) we use a "Multiple - Indicator Multiple- Cause" (MIMIC) framework, which was developed by Jöreskog and Goldberger (1975). In order to estimate all the coefficients of all the equations of the system, the 3SLS technique is adopted, using panel data.

The results revealed that the degree of competition has a significant effect on the performance of telecommunication, which in turn affects the labor productivity. Furthermore, there is no correlation between the openness in telecommunication and the degree of competition in terms of the number of operators.

The rest of this article is structured as follows. The first section presents the stylized facts. The literature review is summarized is Section 2. The third section is the empirical strategy. The results are presented in Section 4. Section 5 concludes.

2. LITERATURE REVIEW

Table 1 presents the evolution of mobile telephone subscriptions from 2011 to 2016 in ECOWAS countries and in Africa overall.

Table-1. Mobile-cellular telephone subscriptions from 2011 to 2016

Country	Mobile-cellular telephone subscriptions			Mobile-cellular telephone subscriptions per 100 inhabitants		
	2011	**2016**	**2011 - 16**	**2011**	**2016**	**2011 - 16**
Benin	7765	8892	14.51	82.08	81.79	-0.1
Burkina Faso	7682	15404	100.52	47.77	82.61	11.6
Cape Verde	396	602	52.02	78.03	111.56	7.4
Côte d'Ivoire	17344	27451	58.27	83.01	115.85	6.9
Gambia	1401	2838	102.56	80.23	139.23	11.7
Ghana	21166	38305	80.97	84.25	135.8	10
Guinea	4861	*10800*	122.17	44.05	*87.13*	*14.6*
Guinea-Bissau	733	1286	75.44	45.9	70.82	9.1
Liberia	2021	3117	54.23	49.655	67.56	6.4
Mali	10822	20218	86.82	69.63	112.35	10
Niger	4743	8720	83.84	27.79	42.18	8.7
Nigeria	95167	154342	62.18	58.43	82.98	7.3
Senegal	9353	15186	62.36	70.32	98.54	7
Sierra Leone	2137	6279	193.82	32.32	84.9	21.3
Togo	2695	5505	104.26	40.35	72.38	12.4
ECOWAS	**188286**	**318945**	**69.39**	**893.815**	**1385.68**	**55.02**
AFRICA	**441338**	**715452**	**62.10**	**51.92**	**73.44**	**41.44**

Source: author, ITU database (2017).

In Africa, in the sector of telecommunications, State interventionism through a public operator monopoly has been the rule since independence, which occurred largely during the 1960s. The justification was twofold. Telecommunications are a "development multiplier" and thereby a public interest. Second, it is explained by relatively high fixed costs for the telecommunication infrastructure. This sector is considered as a natural monopoly. During the 1980s, the environment and the governance framework changed. It is indeed the period of structural adjustment programs (SAPs), particularly promoted by the World Bank. With the wave of marketing and the new goals of liberalization, the majority of countries have separated the positions of telecommunication, the latter being entrusted to an operator with a monopoly on infrastructure. This situation of non-competition enabled agencies to maintain a high level of pricing despite the poor quality of the services offered. The necessary investments for the modernization of the networks were out of postcolonial nations face more pressing priorities such as health, nutrition and education. Several factors brought legislative reforms in the telecom liberalization sector in several African countries.

There is abundant literature on the link between the service sector and growth. However, studies on the liberalization of the telecom sector and productivity are scare. Most of these studies cover Europe and the United States. Previous studies focused on the sectoral performance of services. Some of them assessed the link between the trade openness in services and the sectoral performance in telecommunication. Others evaluated the relationship between the sector performance and productivity. Overall, these studies found a positive and significant link between trade openness in services and the sector performance (Claessens *et al.*, 2001); (Boylaud and Nicoletti, 2000).

Moreover, these results suggest the existence of an indirect relationship between the trade openness in services and economic growth. Literature revealed the existence of a relationship between services trade policy and sectoral performance, and between performance and income growth, respectively (Francois, 2002; Wang, 2006). Francois (2002) established a chain of causality between the opening of financial services and growth. According to their results, the trade liberalization in services helps decreasing the concentration of the structure of the market. In turn, this will reduce market power and will contribute to sectoral performance, which will create a stronger economic growth.

In the "Solow paradox", Solow (1987) concluded that ICT has no effect on labor productivity. Other authors, however, revealed a positive and significant effect (Debonneuil, 2000; Rispal, 2009). In the telecommunications sector, the trade openness, measured by the commitments made by countries under the GATS, has no correlation with the level of competition (number of operators). However, the competition has a significant effect on the accessibility of telecommunications services that influence in turn revenues' growth significantly.

During the period 1970 to 1980, a study conducted in the United States reveals a considerable level of spending. However, these expenditures had no effect on the productivity of telecom users. Solow theorized that as the "Paradox of Solow" or "Productivity paradox". He questioned the benefits of this technological revolution and technological change in situations of high learning costs. This paradox *"you can see computers everywhere except in the productivity statistics"* has been the subject of criticism. Hilady Rispal (2009) said that the emergence of New Technologies of Information and Communication (NTIC) has gone hand in hand with a new growth regime since the 1980s. Dissemination is based on a reorganization and technical progress. The slowdown in growth since 1980 in some developing countries reflects the imperative for economies not only to integrate NICTs to achieve a path of expansion but also to operate costly and mutations.

Cohen and Debonneuil (2000) rejected this paradox by showing that since the 1990s, the rate of growth and productivity gains were correlated positively to the development of ICTs. Investment in research and development, the French revolution and mixed fiscal and monetary policies have allowed a sustainable high growth. The role of supervision of the State appears as a concomitant investment determinant in the economy of knowledge, innovation and technical progress and as a result of growth in the long term. Capirossi (2002) examined the Solow paradox. He estimated that the paradox is not true regarding information on technology and productivity. This paradox is related to the measurement tool chosen. Value added does not account for the delay effects of investment, the time of penetration of information technologies, services to the customer or the increase in the quality of the product. A suitable choice of the measuring instruments allows highlighting the effect of investments on the company added value. Instead, he discovered the existence of another paradox: value added is not accurately capturing the impact of technology information on profitability. This is because the impact of the use of technology information does not always appear in the profitability ratios. It may therefore appear exogenous since it allows reducing communication and transaction costs.

To evaluate the effect of structural changes in the telecommunication market, following the infrastructure liberalization and the privatization of the dominant Deutsche Telekom, on production and employment in Germany, demonstrated that the evolution of the sector with the entry and growth of new players resulted in a change of the production function (by directing the production and demand to new services, opening market niches and providing the promotion of the outputs) . They also noted a change in the level and structure of telecom prices. This change is based on the workforce reduction and the increase in the number of workers.

Few researches focus on the impact of service trade liberalization and labor productivity. Using a panel of firm level data, Topalova and Khandelwal (2011) examines the effects of India's trade reforms in the early 1990s on firm productivity in the manufacturing sector, focusing on the interaction between this policy shock and industry, firm and environment characteristics. He finds a significant productivity boost was generated by the lower tariffs on intermediate inputs as well. Interestingly, state-level characteristics, such as labor regulations, investment climate,

and financial development, do not appear to influence the effect of trade liberalization on firm productivity. Finally there is strong suggestive evidence of complementarities between trade liberalization and industrial policies that encourage domestic competition. The rapid and comprehensive tariff reductions–part of an IMF-supported adjustment program with India in 1991–allow us to establish a causal link between inter-industry and inter-temporal variations in output tariffs, input tariffs, and effective rates of protection and consistently estimated firm productivity. Specifically, reductions in trade protectionism led to higher levels of firm productivity.

Some authors bring new evidence on the impact of services liberalization on performance of manufacturing firms. Using a unique database of Ukrainian firms in 2001-2007, they utilize an external push for liberalization in services sector as a source of exogenous variation to identify the impact of services liberalization on total factor productivity (TFP) of manufacturing firms. Their results indicate that a standard deviation increase in services liberalization is associated with a 9 percent increase in TFP. Allowing services liberalization to dynamically influence TFP through the investment channel leads to even higher effect. The effect is robust to different estimation methods and to different sub-samples of the data. In particular, it is more pronounced for domestic and small firms, Shepotylo and Vakhitov (2015).

Arnold *et al.* (2015) observed that the growth of India's manufacturing sector since 1991 has been attributed mostly to trade liberalization and more permissive industrial licensing. Their research demonstrates the significant impact of a neglected factor: India's policy reforms in services. The authors examine the link between those reforms and the productivity of manufacturing firms using panel data for about 4,000 Indian firms from1993 to 2005. They find that banking, telecommunications, insurance and transport reforms all had significant, positive effects on the productivity of manufacturing firms. Services reforms benefited both foreign and locally-owned manufacturing firms, but the effects on foreign firms tended to be stronger. A one standard-deviation increase in the aggregate index of services liberalization resulted in a productivity increase of 11.7 percent for domestic firms and 13.2 percent for foreign enterprises.

To conclude our literature review, we notice that it is a lack of studies at micro level and macro level which analyze the impact of trade liberalization in telecommunication sector on labor productivity. To face this, our research aims to evaluate the impact of telecomm service trade liberalization on labor productivity in ECOWAS zone.

3. DATA AND METHOD ANALYSIS

3.1. Theoretical Framework Model

We use the MIMIC model to estimate the market power in the telecommunications industry. Before presenting the MIMIC model, we display the basic model of pricing in imperfect competition, concerning market power on the market of telecommunications and the price. To explore the interactions in oligopoly, we use the cyclically model of Cournot. We assumed that each company gives a homogeneous product, faces a downward-sloping demand curve and adjusts its production compared to the production of other suppliers on the market to maximize its profits, with a common market price as the balancing variable. We assume that the telecommunication industry comprises N identical companies producing a public good.

$$X_{ct} = NX_{ict} \tag{1}$$

Where *Xict* is the amount provided by the firm i in country c and the period t. after transformation and linearization, the following structural equation is:

$$\log(PX_{ict}) = \log(MC_{ict}) + \log(\theta_{ict}) \tag{2}$$

This equation expresses the logarithm of prices as the sum of the logarithms of marginal costs, MC, and market power, θ.

For a given country (c), we assume that the firms are identical within each segment (mobile or fixed), but are different between the segments. Thus, the following relation is written without the index (i) firms, but with the introduction of index (s) indicating the segments of telecommunication. The model to estimate is:

$$\log(PX_{ct}^{s}) = \lambda^{s}\log(\theta_{ct}^{s}) + \alpha_{0}^{s} + \sum_{k=1}^{K}\alpha_{k}^{s}\log(S_{kct}^{s}) + \xi^{s} \text{ where s =1, 2.} \quad (3)$$

This equation consists of a system of two functions of supply, one for each segment. θ_{ct}^{s} are the measurement errors of mean zero which are distributed independently on (c) and a finite variance-covariance matrix. S_{kct}^{s} represents k exogenous factors on the supply side explaining the marginal cost for the segment (s) in the country (c) at the time (t). α_{k}^{s} is the coefficient corresponding to the variable k.

The market power in this model is therefore an average market power of the telecommunications market for a given country. It can be specified as:

$$\log(\theta_{ct}) = \beta_{O} + \sum_{k=1}^{K}\beta_{k}\log(F_{kct}^{s}) + V_{ct} \quad (4)$$

where V_{ct} is a distributed random disruption regardless of zero mean and finite variance.

F_{kct} are observed independent variables which determine the market power and β_{k} is the corresponding coefficient.

The regression of the model involves the estimation of a system of two equations (equation for each segment):

$\log(PX_{ct}^{s}) = C^{s} + \sum_{k}^{K}\varphi_{k}^{s}\log(F_{kct}^{s}) + \sum_{k=1}^{K}\alpha_{k}^{s}\log(S_{kct}^{s}) + w_{ct}^{s}$ under the constraints of equations

$$C^{s} = \lambda^{s}\beta_{O} + \alpha_{O}^{s} \text{ and } \varphi_{k}^{s} = \lambda^{s}\beta_{k} \quad (5)$$

Here, we present the chain of causality between the openness in telecom services and the labor productivity in three steps.

First step: The structure of the market based on trade Openness.

The first step is to link the level of competition to the openness of trade services. As in *Francis et al.* (2002), the specification is given in the equation:

$$\mathbf{logCOMP_{it} = b + \alpha_{1}logLIB_{it} + \lambda_{1}logPERF_{it} + \beta_{1}logE_{it} + w_{it}} \quad (6)$$

where COMP is an indicator measuring the structure of the market and is a log-linear function of the opening, LIB is an indicator of performance, PERF allows taking into account the simultaneous relationship between performance and the structure of the market, E_{it} is a set of control variables assumed exogenous. w_{i} represents the error term; α, λ and β are parameters to be estimated.

Second step: Sector performance based on the structure of the market of services. The literature on the performance of telecom services usually considered a simple linear form of specification. This is applied both to the studies in developed countries (Boylaud and Nicoletti, 2000) as well as developing ones Fink (2003) and Doumbouya (2004).

The model of the performance of service is then specified in reduced form where the KPI ($PERF_{it}$) is expressed in log-linear depending on the level of competition ($COMP_{it}$), in the area of service and the matrix of control

variables (D_{it}). The indicator of growth, Y_{it}, is also included to account for the simultaneous relationship between the growth and market performance. The specification is as follows:

$$\log PERF_{it} = b_2 + \alpha_2 \log COMP_{it} + \lambda_2 \log Y_{it} + \beta_2 \log D_{it} + V_{it} \quad (7)$$

where the indices *i* and *t* respectively indicate the country and the period, Vit is the equation error term contained in the previous equation; α_2, λ_2 and β_2 are parameters of the performance equation that we estimate.

Third step: The sector performance and productivity of the work

After the specification of the links between openness and the service performance, this step completes the chain of causality by establishing a relationship between labor productivity and sectoral performance. We consider a standard growth model, in which performance indicators are introduced. The underlying model of endogenous growth of real GDP per capita is Barro (1997). Here, we adapt this model using the labor productivity measure proposed by Balassa-Samuelson. In addition to the classical explanatory variables, namely the factors of production (gross fixed capital formation as a proxy for investment, the ratio of secondary education as approximation of human capital), control variables are set up for human development (life expectancy), macroeconomic policies (inflation), openness (exports as a percentage of GDP), governance (political stability) and demography (population growth).

The model specifies the measurement of the performance of services is as follows:

$$\log Y_{it} = b_3 + \alpha_3 \log PERF_{it} + \lambda_3 \log Y_{i(t-1)} + \beta_3 \log C_{it} + U_{it} \quad (8)$$

where Y_{it} is the ratio of GDP per capita, C_{it} is a vector of growth control variables; $Y_{i(t-1)}$ is the ratio of the per capita GDP of the previous year.

In summary, we have three equations system that looks like this:

$$\begin{cases} \log COMP_{it} = b_1 + \alpha_1 \log LIB_{it} + \lambda_1 \log PERF_{it} + \beta_1 \log E_{it} + w_{it} \\ \log PERF_{it} = b_2 + \alpha_2 \log COMP_{it} + \lambda_2 \log Y_{it} + \beta_2 \log D_{it} + V_{it} \\ \log Y_{it} = b_3 + \alpha_3 \log PERF_{it} + \lambda_3 \log Y_{i(t-1)} + \beta_3 \log C_{it} + U_{it} \end{cases} \quad (9)$$

where i is the ECOWAS countries; t is the period of the study, 2000 to 2012.

3.2. Variable Description

The performance of services Telecom ($PERF_{it}$) can be defined in terms of quality of service (failure rates of calls), the productivity of industry (report of the number of rows work input), prices of services and the accessibility of services (Boylaud and Nicoletti, 2000). Due to lack of appropriate data, we consider only the penetration in the mobile sector, a measure considered by Doumbouya (2004) as part of the quantitative empirical studies on the African countries.

The structure of the market ($COMP_{it}$) in telecom is measured by the number of operators in the mobile segment. By entering the competition, improving the structure of the market should be positively correlated with the accessibility of services. The trade openness in telecom services, LIB_{it}, is measured by the number of years since the commitment of the GATS (see Djiofack-Zebaze and Keck (2009)). The matrix of control variables, E_{it}, the equation of the structure of the market (i) includes the following variables:

- the size of the market which is the main determinant of the structure of the market of services stressed by Francois (2002) a vast market would increase the possibility of competition in the presence of economies of scale. It is measured by the size of the population and the weight of the GDP of the countries of ECOWAS in global GDP;

- the indicator of performance taking into account the simultaneous causality between the performance and the introduction of competition;
- the measure of productivity indicator is relative GDP. That is the relationship between the GDP of the country i and the world countries. In doing so, this relative GDP increase means that country i gaining competitiveness against the rest of the world (Balass - Samuelson effect).

The matrix of variables to control in the model of performance, D_{it} includes the following variables.

The price of local fixed telephony, measured by the official price of a phone call to three minutes in dollars. It is possible that mobile and fixed may be substitutable products, both offering the same service. Therefore, the sign associated with the fixed price could be as much negative as positive.

Price Mobile: the sign is negative, since the reduction would allow an increase in subscriptions.

Table-2. Variables and indicators

Equations	Variables	Indicators	Expected signs
Equation (i)	Dependent variable: COMPIt	Number of operators	
	Liberalization: LIBit	Opening of telecoms services	+
	Performance: PERFit	Penetration	-
	Controls: Eit	Regulation of telecommunications	+
		Size of the market	+
		Population	+
Equation (ii)	Dependent variable: PERFit	Penetration	
	YIT	GDP per capita	+
	Structure of the market: COMPit	Number of operators	+
	Controls: Dit	Price for fixed delay	+
		Delayed price for mobile	-
		Density	+
		Time	-
Equation (iii)	Dependent variable: Yit	Productivity	
	Performance: PERFit	Penetration	+
	Instrument	Relative real GDP delayed	+
	Controls: Uit	Population growth rate	+
		Open trade	+
		Life expectancy	+
		Inflation	-
		Institutions	+
		Tertiary education	+
		Investment	+
		Time	+

3.3. Estimation Technique

To jointly estimate the system of three equations (that of the market structure, the indicator' performance and growth, respectively), we use the *three stage least square* estimator (3SLS). One advantage of the 3SLS is allowing the estimation of all the parameters of the model at the same time. Also, it takes into account a possible correlation between the error terms if the structural model. Thus, the simultaneity bias is corrected by the use of internal instruments. The 3SLS estimation procedure is described in Zellner and Theil (1962): first, the exogenous variables are regarded as instruments for the endogenous variables using ordinary least squares (OLS). Then, each endogenous variable is regressed on the two exogenous variables and forecasts of the endogenous variables. This is the procedure of double OLS (DMCO). Finally, the method of generalized least squares (MCG) estimator is calculated in order to use the contemporary correlation of the error term. The main advantage of using the 3SLS over the 2SLS is an increase in the estimates efficiency. However, if the 3SLS is asymptotically best, it has the disadvantage of a specification error in the model structure. Therefore, we will present the results for the two estimators.

3.4. Data and Sources

The performance of telecommunications indicators data are obtained from the ITU. Liberalization of telecommunications indicators have been developed on the basis of ITU and the WTO commitments schedules. The data on economic performance, structure and determinants of growth are taken from the World Bank, *World Development Indicators* (WDI) database. Governance indicators are from World Governance Indicators (WGI).

4. RESULTS AND DISCUSSIONS

In ECOWAS, the degree of trade openness (exports as a percentage of GDP) is on average 27. 64 percent. GDP per capita varies between $ 155 and $ 3320 with an average of $625. The level of labor productivity in the ECOWAS has averaged 0,086. In the telecom sector, prices in the fixed segment remain relatively low compared to those in the mobile segment. When the price in the fixed segment was around 0.11 dollars, it had quadrupled in the mobile segment. However, the rate of penetration in the mobile segment is still high (25, 43%). Tertiary education remains low in the area. Indeed, the rate of tertiary education is an average of 4.43% in the community. The investment is an average of 16.62% within ECOWAS. The variable 'institution' is negative, suggesting that the ECOWAS countries lack political stability.

Table-3. Descriptive statistics of the variables used

Variables	Comments	Average	SD	Maximum	Minimum
Mobile subscription	195	25.42	27.25	100.28	12.40
Labour productivity	195	.08	.077	.42	.022
GDP per capita	195	625.2	573.24	3320.86	155.45
Fixed price	195	.11	.158	1.34	0.05
Mobile price	195	.43	.48	2.33	0.06
Opening	195	27.65	12.10	91.51	12.5
Institutions	195	-.54	.89	1.12	-2.37
Tertiary education	195	4.42	10.06	45.88	2.45
Investment	195	16.62	9.43	46.73	5.52

Source: author, results

Table-4. Econometric results using 3SLS

	Coef.	STD.	z	P > z	Confidence interval	
Structure of the market						
LLIB	-.0572999	.0226816	-2.53	0.012	-.101755	-.012844
lPERF1	.0234046	.0210243	1.11	0.266	-.0178023	.064611
Ldim	-.1612806	.0456983	-3.53	0.000	-.2508476	-.071713
Pwpa	.3439975	.0553388	6.22	0.000	.2355354	.452459
_cons	-4.965734	.9767115	-5.08	0.000	-6.880054	-3.05141
Market performance						
LCOMP	1.512636	.2774186	5.45	0.000	.9689058	2.05636
Lprod	.0234046	.0210243	1.11	0.266	-.0178023	.064611
Lpfixe	.3622022	.0978409	3.70	0.000	.1704375	.553966
Lpmobile	.1393899	.2953645	0.47	0.637	-.4395139	.718293
LGDP	1.354628	.2242169	6.04	0.000	.9151709	1.79408
Ldensit	.2757014	.1519267	1.81	0.070	-.0220694	.573472
_cons	-7.762421	1.256987	-6.18	0.000	-10.22607	-5.29877
Labour productivity						
LPERF1	.0003189	.0002488	1.28	0.200	-.0001687	.000806
Lprod	1.001009	.0092897	107.75	0.000	.9828018	1.01921
Lcrssepop	-.0032311	.0012331	-2.62	0.009	-.005648	-.000814
Lexports	-.0010928	.0005705	-1.92	0.055	-.0022108	.000025
Lesper	-.0002092	.0041109	-0.05	0.959	-.0082664	.00784
Inflation	-.0000111	.0002712	-0.04	0.967	-.0005426	.000520
Linst	.0003234	.0004405	0.73	0.463	-.0005401	.001186
Leduc	.0002168	.000048	4.51	0.000	.0001226	.00031
Linv	.0005796	.0003927	1.48	0.140	-.0001901	.001349
_cons	.0042127	.0157488	0.27	0.789	-.0266545	.035079

Source: author

4.1. Effects of the Opening of Telecommunications in the Structure of the Market Services

The results denote an absence of correlation between the openness in telecom services, and the penetration rate. This is explained by the low level of participation of ECOWAS countries in terms of commitments under the GATS. This result is in line with the study of Keck (2006) on African countries.

Although these commitments have no significant effect on the competitiveness of mobile phone operators, they positively impact competitiveness. If the countries' commitments increase by a point, there is an increase in the number of operators of 0.04 points. This result is consistent with the objectives of the liberalization in the telecom sector. It indicates that if countries contract commitments, there will be a greater openness in the telecom market. This will result in an increase in the number of operators in the different segments of the telecommunications market. However, it should be noted that the number of operators alone is not enough to practice a competitive game. There is a need for a more independent Regulatory authority.

The penetration rate has a positive and significant effect on telecom market competitiveness. An increase of 1% in the penetration rate improves the competitiveness by 0.18%. This result is interesting insofar as it shows that the larger the market, the greater operators' role in a competitive game. Here again, we stress the role of the regulator authority in the development of the competitive environment.

4.2. Effects of the Structure of the Market Performance

Results show a 1.51 % positive and significant contribution of the market structure to the operators' performance in the telecom sector. This confirms the existence of an inverse relationship between performance in the telecom and the GDP per capita growth as introduced in equation 2. These results are in line with that of Sridhar (2004) on developing countries. The increase in the number of operators on the telecom market leads to an improvement in the sector performance. Gross domestic product per capita has a positive influence (0.0003) and is significantly to the same threshold on the performance of the telecommunications market. GDP per capita can be considered a measure of purchasing power, its positive influence on the sector performance is explained by the fact that the more consumers have the purchasing power, the more they ask the services of telecommunications over the size of the market will increase to operators.

The population density significantly and positively affects the penetration rate in the telecom. It induces an increase in the penetration rate of 0.28%. Other variables such as prices in the fixed and mobile segments are not significant. The coefficient associated with the price in the fixed segment is positive (0.05), which implies that a rise in the price of this segment increases the penetration rate. The coefficient associated with the mobile segment is negative (-0.34). Next, we examine the effects of the sector performance on the labor productivity.

4.3. Effects of Sectoral Performance in Telecommunications on the Productivity

The estimation of the productivity model gives a significant and positive relationship (0.0003) for the penetration rate. This validates the existence of an inverse relationship between productivity and performance. There is also a positive and significant contribution (0.002) between relative real GDP and spending on tertiary education. Spending on tertiary education contribute to the increase in relative real GDP and therefore an improvement in the performance of the telecommunications sector.

In short, even if the commitments under the GATS are without effect on the structure of the telecommunications market, a 1% increase in the degree of competition in the telecom leads to a 0.02% increase in the accessibility to mobile phone services. A 1% increase in the access to telephony services translates a 0.0003% increase in relative real GDP and therefore an improvement in productivity. This weak coefficient is explained by the fact that the penetration rate of telecom services in ECOWAS countries is relatively low. However, we notice a very rapid evolution. These results are highly consistent with those past studies, including Sridhar (2004).

5. CONCLUSION

One benefit of efficient telecommunication services is the improvement of countries' competitiveness. According to the WTO, telecoms are the new highways of modern commerce. Previous studies agree on the valuable effect of measures, including the privatization of State monopolies, the introduction of competition and the creation of regulatory bodies independent. Countries that engaged in large-scale reforms in this sector have had remarkable results. Countries which fully liberalized their financial and telecom services have performed better, with an average of 1.5 percentage point ion economic growth compared to other countries. The liberalization of trade and the arrival of foreign operators are important factors for restructuring the sector.

This article contributes to the literature by examining the indirect link between the telecom liberalization and the labor productivity following Francois (2002) and Wang (2006). This link highlights two plausible effects: on the one hand, the telecom liberalization contributes to the reduction in the market structure concentration. In turn, this reduction entails a decrease of the market power, and thus an increase in the productivity of labor.

These estimates give mixed results. The telecom openness, measured by the commitments made by States in the context of the General Agreement on trade in Services (GATS) at the WTO, is not correlated with the degree of competition (measured in terms of the number of operators). However, the competition degree has a significant effect on the telecom performance, which in turn impacted significantly the productivity of labor. In addition, these results confirm the findings of Sridhar, who found a significant effect between the penetration rate and the level of competition in trade services in Africa (Sridhar, 2004).

On the basis of our results, the regulation in the telecommunications sector needs to be strengthened in order to reduce operators' monopoly power. Thus, we will witness a great penetration of telecommunications services in the ECOWAS countries. In doing so the goal of universal service access would be achieved and the productivity of the work factor will improve.

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