academicJournals

Vol. 7(11), pp. 256-263, November, 2015
DOI: 10.5897/JASD2015.0343
Article Number: D75045956067
ISSN 2141 -2189

http://www.academicjournlas.org/JASD

Journal of African Studies and Development

Full Length Research Paper

Fixed and mobile telephones in West African Economic Monetary Union countries: complementary or substitute services?

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Received 30 April 2015; Accepted 12 October, 2015

The observation of the joint evolution of fixed and mobile phones penetration in West African Economic Monetary Union countries suggests that the demand of the two services does not develop at the same rate with increasing difference in favor of the mobile phone. This article is dedicated to relationship between fixed and mobile phone services. It tests empirically the existence of relations of complementarity and substituality between these two types of services in the West African Economic Monetary Union countries over the period 1997 to 2010. It is clear that in these countries, mobile phone is a fixed phone substitute, although the extent of this relationship of substitution is relatively low. Nevertheless, the role that the fixed phone is required to play in these countries for ICT services development must push the authorities to consider measures to improve the fixed phone penetration rate.

Key words: Telephone, substituable, panel data, WAEMU.

INTRODUCTION

The West African Economic Monetary Union (WAEMU) comprises eight countries[i]. This regrouping aims primarily for the promotion of the economic growth and the improvement of the standard of living of its populations by the means of economic integration. Many economic and institutional reforms were undertaken in particular within the framework of the Programs of Structural Adjustment, whose challenges were the reduction of the deficits, the deceleration of the rise of the prices, the liberalization of the exchanges and privatization (Beitone et al., 2010, p. 345). These reforms concerned, in particular, the sector of telecommunications, which seems to be a sector which can play a role of catalyst in the process of economic growth.

The reforms in this sector are marked by the opening of the market, formerly dominated by the fixed phone, on the mobile phone, with the arrival of private operators and competition. The result of these reforms is rather perceptible in comparison with the volume of the private investments on a large scale, a total value of

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JEL Codes: D43 – D65 – C23

approximately twenty billion US dollars, and the rapid growth of the number of subscriptions on the mobile phone provided in each country (one records at least two operators per country). Between 1992 and 2005, the major part of the eighty two transactions of the private sector in Information Communication Technologies (ICT) related to new operations in the mobile phone sector (Banque, 2010). It is a good idea to specify that the fixed phone and the mobile phone are both communications network allowing the economic agents to communicate. They are, thus, two essential services in the sharing and the flow of information, as in the management of the economic exchanges. According to the technologies and the level of development of a country, the fixed phones and the mobile phones can be considered, either as complementary properties, or as substitute ones.

The impressive increase in the mobile communication in the world led to more than four billion users in recent years and was accompanied by a significant fall of the subscription to the fixed network (Vogelsang, 2010). In 2002, with a billion users in the world, the mobile communications have for the first time exceeded that of the subscribers to the fixed phone (Garbacz and Thompson, 2007).

The adoption of the mobile phone was done very quickly in the WAEMU countries. After more than ten years of existence, the number of subscriptions to the mobile phone network has already largely exceeded the number of functional fixed lines. The access to the fixed phone has also increased, but less than the mobile phone.

In 1997, one counted only 54,675 subscriptions to the mobile phone in all the eight countries of the WAEMU zone. At the same time, one counted 404,299 fixed functional principal lines. Three years later, at the end of the year 2000, this trend was reversed, and the number of subscriptions to the mobile phone (866,378) exceeded that of the subscriptions to a fixed principal line which is 687,516 (Table 1). The ratio of the number of mobile phone and principal fixed line was established to 1.2 in 2000 against only 0.14 in 1997.

From 2001, even if one noticed a progression of the number of the subscriptions for the two types of telephone, the progression of the mobile phone was very high and was done very quickly. In all the West African Economic Monetary Union, there were more than 32 times mobile phones compared to fixed principal lines in 2009; moreover, 4 inhabitants out of 10 hold a mobile phone (ITU, 2011). In spite of its lightning evolution and its prices competition the mobile phone users' benefit from its usage, their desire for the fixed phone did not change, which seems almost in situation of monopoly in the WAEMU countries.

One observes in addition that the increase in the access to the mobile obviously affected the fixed line, which leads us to question on the nature of the relation between the fixed phone and the mobile phone, following the paramount importance of the latter. Is it a complementary relation or substitution? It is with this question that we will try to bring a response in the continuation of this article, which is structured as following: the review of the literature (section 2), the methodological approach (section 3), empirical results (section 4) and the conclusion (section 5).

The review of the literature on the link between mobile phone and fixed phone

From a theoretical point of view, the growth of the mobile communication network can be related to an initial increase in the traffic on the fixed network, because of the existence of a relation of complementarities between the two services. The growth of the mobile network could be associated to a fall of the fixed network traffic, because of the prevalence of the substitution effects between the mobile phone and the fixed phone. The existence of these two links is rather present in many work listed in the literature.

The complementary relation between the fixed phone and the mobile phone

Traditionally in the developed countries, the mobile phone is regarded as a complementary service to the fixed phone, because it seemed to be a need and also because the fixed network has other functions likely to support the access to the pass-band (Hodge, 2005; Hamilton, 2003). Several studies were undertaken on the question in these countries, and some of them (Gruber and Verboven, 2001; Sung and Lee, 2002) drew the following conclusion: in spite of its rapid progression, the mobile phone is a complementary service to the fixed phone. The major rationale evoked to justify such a relation is based on the easiness of the mobile phone network installation and to function in an area where the access on the fixed phone is weak or non-existent, even temporarily impossible because of the isolation[1]. Vagliasindi et al. (2006, p. 365) in their study on competition between the fixed phone and the mobile phone in the economies of transition concluded that the adoption of the mobile phone in these economies is a tremendous alternative for the fixed telephone line, and led to significant advantages in terms of coverage areas and connectivity of the population, particularly in the countries where the services of fixed phones are not reliable.

[1] The installation of the mobile network can be, for example, attractive in a region where it is difficult to proceed to the installation of the fixed telephone line. In the WAEMU countries, the installation of a fixed line

Table 1. Number of the phones subscribers (mobile and fixed) in the WAEMU zone.

Years	Fixed subscribers	Mobile subscribers
1997	404 299	54 675
1998	473 793	141 037
1999	573 084	382 897
2000	687 516	866 378
2001	779 087	1 352 665
2002	815 394	2 178 943
2003	755 551	3 111 864
2004	826 541	4 602 205
2005	864 888	6 927 665
2006	924 999	11 981 654
2007	957 259	19 678 721
2008	1 132 814	29 402 867
2009	1 184 564	37 668 410
Average growth (1997 – 2009)	9,37	72,40

Source: Achieved from data of the ITU (2011).

has become a reality after a long period of time which runs out between the moment when the request for connection to the network is expressed and the moment when the line is installed. This time can last for several years in certain countries. As the access to the fixed network cannot be made as fast as the mobile, this has fostered the potential users to prefer the mobile phone. It then makes it possible to even reduce or eliminate the non satisfied request on the fixed network, the two services being thus linked by a complementary as far as the access to the network is concerned.

When we consider the mobility offered by the mobile phone, it is also possible to regard these two communication systems as complementary services. Indeed, the fixed phone is generally used at the house and the office, while the mobile telephone is used during movements. So the mobile phone makes it possible to the individuals to make the junction between the house and the place of work, without risk to lose calls.

Technical compatibility between mobile technologies and fixed ones makes also mobile telephone a good complementary service to the fixed phone. The presence of the mobile phone then confers a benefit to the users of the network of existing fixed telephone, because of the increase in the potential number of people they can call. The positive externality of the network generated by the mobile network increases the utility of the fixed network and by this fact increases the fixed demand for telephone, and the analyses based on the costs of the services offered by the two networks also emphasize a complementary relation between them. It comes out from these rationales three forms of complementarities between the mobile phone and the fixed phone: complementary of the uses, complementary of the infrastructures and complementarities related to the effects of networks. These rationales are backed up by other work on the relation of substitution between these two networks.

The relation of substitution between the fixed phone and the mobile phone

A certain number of researches established the existence of a relation of substitution between the mobile phone and the fixed phone. Rodini et al. (2003, p. 475) in an analysis of the consequences of substitution between the fixed phone and the mobile phone in the USA, the expansion of the mobile network, showed basing on an estimation of the crossed elasticity-prices that the mobile phone service is a substitute of the fixed phone. They showed, moreover, in comparison with the trend observed on the side of the users that these services will become with the time the perfect substitute because of the fall of the prices and the increase in the services offered by the mobile network operators. Ward and Woroch (2004, p. 13), whose study was also on the relation between the fixed phone and the mobile phone in the USA concluded that the mobile service is a substitute for the use of the landline telephone not by considering the aspect access to the services, but the level of the traffic (consumption).

Another rationale in favour of the existence of a relation of substitution is the use of potential the prepaid cards

which the operators of the mobile network offer to their users. Indeed, the system of prepaid makes it possible to the users of the mobile phone to control in real time the expenditure carried out, which avoids the risks of unpaid telephone bill which can lead to the suspension of the landline telephone. The mobile and fixed phones are thus substitute services, and it is certainly to face this phenomenon of substitution that the majority of the operators of fixed network (the West African Economic Monetary Union zone) adopted the use of the prepaid cards. However, this strategy did not make it possible very significantly to increase the resort to the use of the fixed phone in these countries.

The ambiguous relation between the fixed phone and the mobile phone in the African countries

In the African countries, few empirical studies were carried out on the question and did not allow drawing a final relation between the mobile phone and the fixed phone. As a whole, the results obtained are debatable. Indeed, some studies led to results establishing the existence of a relation of substitute between the mobile and the fixed (Frempong and Atubra, 2001; Esselaar and Stork, 2005), whereas others concluded that it is possible that the fixed telephone and the mobile telephone are substitute services to somehow; these services can become complementary in consumption even if the access to a landline phone is weak (Hamilton, 2003, pp. 124, 126).

Chabossou (2008, p. 165) measured the effect of the modal competition of the mobile phone on the fixed phone in Benin, in a context where the choice of measurement of modal competition is determined by the inexistence of the statistical data about the mobile phone. This study showed that the presence of the mobile phone reduced the use of the fixed phone by the consumers. While making the assumption that these two services make it possible to the consumers to achieve a single goal, that to communicate with other people, it concluded that the mobile phone is a substitute of the fixed phone in Benin. Between an operator of the fixed network and an operator of the mobile network, there is thus a competition, at least for the division of the shares of the market. This result consolidated that of Hodge (2005, p.

504), which was based on microeconomic data to show that the mobile phone plays the role of substitute of the fixed phone in South Africa, particularly for the households having low income.

Esselaar and Stork (2005, pp. 70, 71) in a microeconomic study on a sample of African countries established that the degree of flexibility that offers the mobile phone through the mode of payment in prepaid costs of communication, is a significant factor in the research of the relation between the mobile phone and the fixed phone. This study showed that the households which have a fixed phone express a strong desire of using the mobile phone. In other words, the simultaneous possession of the fixed phone by a household and mobile phone has a positive impact on the income of these households. From this point of view, the mobile phone and the fixed phone are substitute services for all the households, whatever their income.

On the whole, the mobile phone clearly seems to be a complementary service to the fixed phone in the developed countries. On the other hand, in the African countries in the south of the Sahara where the access to the fixed phone is weak, even non-existent in certain areas of these countries, it is not easy to conclude on real nature from the relation which exists between these two services.

We now going to consider this relation in the West African Economic Monetary Union countries (Benin, Burkina Faso, Côte d'Ivoire, Mali, Niger, Senegal and Togo)[2], and this characterization is based on a methodological step which is advisable to present.

METHODOLOGY

The offer and the adoption of the mobile phone is growing quickly, perhaps because several governments have introduced competition on the market of the mobile phone more than on the market of the fixed one. What makes possible a drop of the production costs, a disappearance of the revenues, an improvement of the quality of the offer and a better competition by the prices and off prices. It is not easy to know, on the one hand, the number of people using only the mobile phone or the fixed phone, on the other hand, the number of people who use both. In spite of this difficulty, it is possible to analyze the relation between the fixed phone and the mobile phone by making the assumption of the existence of a modal competition between the two types of means of communication. Within this framework, we suppose that the demand for one is related to that of the other. For this reason, we start with the data of panel borrowed in Hamilton (2003, p. 120), which is as follows:

$$LABF_{it} = \alpha_i + \beta_1 LABM_{it} + \beta_2 LABF_{it}^2 + \beta_3 OPM_{it} + \beta_4 URB_{it} + \epsilon_{it} \quad (1)$$

Where:

- $LABM_{it}$ represents the logarithm of the number of subscribers to the mobile phone during the year t in country i;
- URB_{it} indicates the proportion of the urban population during the year t in country i;
- OPM_{it} is the number of operators who exploit a patent of phone mobile during the year t in country i;
- $LABF_{it}$ which is the variable to be explained indicates the logarithm of the number of functional subscription on the fixed phone during the year t in country i.

Considering the outsourcing of network (club effect) is collected by the $LABF^2_{it}$ variable, which represents the logarithm of the

[2] The Guinea- Bissau is as member of the WAEMU. It is not taken in account because of the no availability of data on this country.

square of the number of subscribers on the fixed phone during the year T in country I. It is also an explanatory variable of the demand for the fixed phone.

A positive sign of the parameter β_1 indicates that the fixed and mobile phones are complementary. In this case, the same person has access both to the mobile phone and to the fixed phone. Conversely, a negative sign of the same parameter could mean as the adoption of the mobile phone is done with the detriment of the fixed phone. As for the parameter β_2, it makes it possible to measure the club effect of the use of the fixed telephone. In theory, the utility of the telephone network grows with the size of the network (a number of users). We make the assumption that this parameter has a positive sign.

The recourse to the data model of panel emphasizes differences between the countries and makes it possible to obtain better results, and the double dimension of the data makes it possible simultaneously to give an account of the dynamics of the behaviors like their possible heterogeneity, which constitutes an advantage compared to the other types of data (Gujarati, 2004).[3]

The estimation of the model used leads us to conclude that the fixed phone and the mobile phone are substitute in the countries under review.

RESULTS

Before carrying out the analysis of the results, it seems coherent to point out how we chose the model appropriate to this end. Initially, it was necessary to test the existence of specific effects, which we made by comparing the model which supposes the homogeneity of these effects (null assumption) and the model postulating their heterogeneity (alternative assumption). The application of the test of Fischer gives a computed value of 66.07, and this value is largely higher than the tabulated value F (7, 100) = 2,10 with the threshold α = 5%. Consequently, the alternative assumption of the heterogeneity of the individual effects has been accepted.

In the second time, it is advisable to know if the individual effects are random or not. The recourse to the test of Breusch-Pagan enabled us to conclude positively, since the value of khi-deux calculated (401.77) exceeds by far that of khi-deux tabulated with the threshold of 5%, that is to say $\chi^2_{0,05}(1) = 3,84$. These two results suggest that one could use either the model for fixed purposes, or the model for random purposes for the estimation of the model selected. The application of Hausman test in the third time enabled us to ultimately choose the model for fixed individual purposes, of which the use for the estimation has given the results contained in Table 2.

The mobile phone: a substitute to the fixed phone in the West African Economic Monetary Union countries

Our estimation indicated that the parameters associated with all the variables with the model (proportion of urban population, number of mobile operators, number of subscribers to the mobile phone, externality generated by the fixed principal lines) are significantly different from zero. It means that all these variables exert a real influence on the number of subscribers to the fixed phone. Considering that the sign associated to the mobile phone is negative, it is concluded that the fixed phone and the mobile phone are substitute products in the West African Economic Monetary Union countries. In other words, although the two products make it possible to the users to satisfy the same need in this space, it is exerted on the market of the telephone a competition between the access to the mobile telephone and the subscription to a fixed principal telephone line. Of course, this competition is not very marked, since the value of the coefficient of variable LABM is very low (-0.0058). This means that an increase of 100% of the number of subscribers to the mobile phone led to a fall of 0.6% only of the number of subscribers to the fixed phone.

An analysis of the annual variation of the demand for the two services has led to give more importance to this purpose in spite of this numerical weakness. Indeed, the mobile phone grows at very high rate which makes that annual variation expressed as a percentage that it generates on the demand for the fixed phone is significant. This result also suggested that there is a modal competition between the fixed phone and the mobile phone. However, this competition is not completely advantageous for the consumers, because the substitution of the fixed telephone by the mobile telephone is not led to the certain shape of monopoly of the mobile telephone, which is not a good thing for the economy of the whole of the West African Economic Monetary Union (WAEMU) countries. Indeed, in the absence of a service of substitution, the oligopolies observed that the markets of the mobile telephone can raise the prices above the price of competition without their customers not having the possibility of being diverted of their service (Angelier, 2007, p. 72).

In the light of the estimated fixed individual effects (Table 2), we can distinguish two categories of country in zone WAEMU: countries for positive fixed purposes (Benin, Togo, Côte. d'Ivoire, Mali and Senegal) and countries for negative fixed purposes (Burkina Faso, Guinea-Bissau, Niger). In the first group, we can find countries characterized by the existence of the non observable factors whose influence is positive to the subscribers to the fixed phone. The annual income per capita seems to be the variable likely to explain this difference, since the countries with average income per capita relatively higher are primarily those of the first group whereas those of the second group are characterized by a level of annual income per capita relatively weak (Table 3). This tends to indicate that the level of wealth of a country influences the access to the

[3] Panel data provides more information, more variability, less colinearities among variables, more degree of liberty and more performance (Gujarati, 2004).

Table 2. Results of the estimations

Variables	Dependant variable : LABF (Log fixed phone subscribers)	
	Coefficient	***t-Statistic***
LABM	-0.0058***	-4.08
LABF2	0.1089***	109.80
URB	-0.0038***	-3.57
OPM	0.0033*	1.71
CONS	2.40893***	102.84
Fixed individuals effects		
BENIN	0.0461	
BURKINA	-0.0387	
COTE IVOIRE	0.0140	
GUINEE-BISSAU	-0.0470	
MALI	0.0155	
NIGER	-0.0403	
SENEGAL	0.0053	
TOGO	0.0451	
N	**112**	
R2 within	**0.9966**	
R2 between	**0.9953**	
F-Stat	**66.07**	
Rho	**0.9134**	

Source: Results of our estimation. Note: * = significant at 10%; ** = significant at 5% and *** = significant at 1%.

Table 3: Income per capita in the WAEMU countries (in FCFA).

Countries	Income per capita in annual average
Benin	344.600
Burkina Faso	217.100
Côte d'Ivoire	510.100
Guinea-Bissau	156.300
Mali	338.500
Niger	177.300
Senegal	393.200
Togo	268.500

Source: Achieved by the author from data of UEMOA (2009).

fixed telephone positively. This result is completely coherent in the context of the WAEMU, and besides it consolidates that obtained by Lemesle (2002, pp. 70, 71).

Apart from Mali, the four other countries for positive fixed purposes are countries having an opening on the sea. This geographical position supports the access and the use of the underwater cables with lower cost, as well as the digitalization and the extension of the network of fixed telephone, from now on used like support of the Internet high flow. The specific effects of Benin and Togo are very close, and that can be explained by the geographical proximity and the division of the cultural practices of these two countries. The weak tariffs of the phone calls starting from the fixed telephone can also be at the base of the positive fixed effects in Benin, Mali and Togo, where three minutes of local call respectively cost 60, 53 and 90 FCFA in average. The group of the countries for negative fixed purposes is characterized by non observable factors which exert an unfavorable influence on the access to the fixed telephone. We could probably think of the capital cost raised for the installation

of the fixed network telephone in these countries, for which it is advisable to add the expenditure of so high maintenances.

From another point of view, the parameter which collects the network effect of the fixed telephone on its own request is positive and significantly different from zero. There is thus an effect of club on the networks of fixed telephone in the WAEMU countries: the more there will be subscribers to the fixed telephone, the more significant will be the new demand for subscription. From this point of view, the club effect will be more significant with the progressive increase in the access to Internet network, the role which the fixed telephone has to play in the developing economies, especially if there are a better access to the broad band-width and an intensification of the use of Internet.

With the multitude of potential uses of the fixed telephone, it is important that the authorities speed up the reforms aiming to the reorganization and the privatization of the public monopolies. Thus, the new operators of the fixed telephone will work to improve and diversify their offers of service, and will be able of this fact of generating another type of externality: the savings in scale which contribute to improve the consumer satisfaction without paying much money (Angelier, 2007, p. 25).

The urban population exerts a negative influence on the demand for the fixed telephone. This result, at least paradoxical, can be explained by the strong concentration of the offer of fixed service of telephone in urban environment and/or the low availability of the fixed service of telephone in the rural areas. Conversely, the number of mobile operators has a positive impact on the fixed telephone in the WAEMU countries, and in its dynamism, the market of the mobile telephone seems to involve, to a certain extent, the market of the fixed telephone to adapt to competition. We can understand then why the relation of substitution found before is weak.

Conclusion

The findings of our work indicate that the mobile phone service is a substitution for the fixed phone, even if the substitution effect remains weak. The weakness of the rate of penetration of the fixed telephone is related to a shortage of supply than to a weakness of demand for the service. A thorough analysis taking into account the evolution of the tariffs of the two services could make it possible to confirm this relation. Even if the substitution effect can appear rather unimportant, it is up to the actors, to leaders of the telephone network, regulators and governments, to take measures allowing the development and the extension of the telephone network, since this network has a paramount role in the development of broad band. These measurements of offer dynamics of the fixed telephone can aim at the privatization of the operator of the fixed telephone in the countries where it is not yet the case (Benin, Niger and Togo) and the opening to competition in the other countries (Burkina Faso, Côte d'Ivoire, Mali and Senegal).

Conflict of Interests

The author has not declared any conflict of interests.

ACKNOWLEDGEMENTS

Author gratefully thank the participants of First Conférence Africaine sur la Régulation et l'Economie de Télécommunication (CARET) at Ouagadougou (November, 2011); thanks to Dr Georges Kobou for constructive suggestions on an earlier version of this paper and those who contributed to the improvement of this paper.

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[i] Benin, Burkina Faso, Côte d'Ivoire, Guinea- Bissau, Mali, Niger, Senegal and Togo