

THE DUAL ROLE OF MOBILE PAYMENT IN DEVELOPING COUNTRIES

***Documents de travail GREDEG
GREDEG Working Papers Series***

**LAETITIA CHAIX
DOMINIQUE TORRE**

GREDEG WP No. 2015-01

<http://www.gredeg.cnrs.fr/working-papers.html>

Les opinions exprimées dans la série des **Documents de travail GREDEG** sont celles des auteurs et ne reflètent pas nécessairement celles de l'institution. Les documents n'ont pas été soumis à un rapport formel et sont donc inclus dans cette série pour obtenir des commentaires et encourager la discussion. Les droits sur les documents appartiennent aux auteurs.

*The views expressed in the **GREDEG Working Paper Series** are those of the author(s) and do not necessarily reflect those of the institution. The Working Papers have not undergone formal review and approval. Such papers are included in this series to elicit feedback and to encourage debate. Copyright belongs to the author(s).*

The Dual Role of Mobile Payment in Developing Countries

Laetitia Chaix* and Dominique Torre*

GREDEG Working Paper No. 2015–01

Abstract

This paper analyzes the capacity of mobile-payment solutions to improve financial inclusion in developing countries. It elaborates from rural East African countries experiences where mobile payment services have developed rapidly. With a simple dynamic model which rationalizes traders' adoption process of distant mobile payment services, we analyze the role of telephonic operators in financial inclusion. We point out the interest of a diversified supply of m-payment services, including simplified solutions proposed by operators alone, in complement of more advanced services involving financial partners. We explain how such a diversified supply, including a “frugal” innovative component, can be more efficient to improve financial inclusion than the only elaborated solutions provided cooperatively by operators and banks cooperatively.

JEL Classification: E42, O33

Keywords: mobile-payment services, financial inclusion, developing countries, switching costs, frugal innovations.

1 Introduction

During the period of emergence of Information and Communication Technologies (ICT), one of the more discussed question was the nature and extent of digital divide (Chen and Wellman, 2004) they generated between developed and developing countries populations (Castells, 1996). Recurrent observations showed however progressively that in some circumstances, developing countries were able to overcome their initial digital handicap and, thanks to ICT, “to support the development strategy of leapfrogging, *i.e.* bypassing some of the processes of accumulation of human capabilities... and narrow the gaps in productivity and output that separate industrialized and developing countries” (Steinmueller, 2001, p. 194). This tendency has rapidly been considered as dominant (Souter, 2004) since the development of the

*Université Nice Sophia Antipolis – GREDEG – CNRS, 250 rue Albert Einstein, 06560 Valbonne, France, Tel: 0033493954361. E-mail: laetitia.chaix@gredeg.cnrs.fr, dominique.torre@gredeg.cnrs.fr

mobile phone and mobile Internet. Mobile phone made communication cheap and easy, minimizing the infrastructure investment and making available various services and information, in many places where telephone and Internet connexions had no chance to impose. ICT are now perceived as having a very positive impact for developing countries and their economies. They allow to accelerate economic growth and reduce the poverty by enabling governments and companies to improve their management or productivity (Asian Development Bank Institute, 2001). ICT development helps to bypass some stages of the development process (Adam and Jacquet, 2005). In these countries, ICT also reduce transaction costs and help companies to increase and diversifies their supply of goods and services (Roller and Waverman, 2001).

This paper contributes to the analysis of the way the diffusion of ICT, and especially of mobile phone contributes to financial inclusion in developing countries. The rapid adoption of ICT in developing countries is indeed able to change payment habits more rapidly than do local and foreign banks for decades, despite their approach adjusted to local customs and mentalities.

The mobile service that allows this inclusion is the money-payment service. The possibility to use cellulars to pay is more interesting when cash is the only accepted means of payment than when everyone has one or many accounts able to be activated by checks or debit cards. This explains the success of mobile payment possibilities in these countries. This success has been documented by an empirical literature. When commercial banks are inaccessible to a portion of the population, they are not considered as efficient institutions (Allen, Carletti, Cull, Qian, Senbet, Valenzuela, 2012; Dupas, Keats Green, Robinson, 2011). In this case, cash is the only way to pay and to be payed and even saving accounts are only opened by a small fraction of the population. Another fraction uses informal channels to manage savings because banks use a written communication unadapted to their habits, and is far from their financial uses and customs. Beyond these cultural factors, there are also economic factors of financial exclusion as inaccessibility or lack of distribution networks (Lyons and Scherpf, 2004), geographic distance (Beshouri *et al.*, 2010) and transaction costs (De Sousa, 2010).

Mobile operators, with or without the support of banks, are then the first candidates to this implementation of m-payment solutions in an environment where mobile phones are far more numerous than banking accounts. Both operators and banks have indeed motives and interests in providing the service. East-African experiences attest that both partners are involved in providing the new service but also that their involvement includes the offer of two different services. The first of them could be qualified of “frugal innovation”. It is provided by the operator alone which does not introduces any new technology but only adapts the existing technology to new uses. This first mobile payment service has the advantage to insert rapidly in existing users habits. The second technology is more elaborated. It integrates additional financial services, is also more secure, but is not immediately adapted to unbanked people. It however allows to users already accustomed to the

first technology to move toward a more serviceable, secure and advanced system, fully compatible with the first one. This second service requires a bank account, but the switch from the operator to the cooperative technology is assisted online.

East African countries experiences attests that this dual offer can be permanent, in an environment where it is not perceived as optimal to offer a single sophisticated service. The research question of this paper can then be formulated as follows: is this dual offer only explained by the heterogeneity of users population – with the objective of covering all the potential demand of m-payment services – or is there another explanation to this coexistence? To answer the question, we elaborate an illustrative model capturing as relevantly as possible the rational choices in term of payment services of potential users in a poorly developed financial environment. We characterize heterogeneity of demand and the nature of institutions, to depict adequately the socio-economic context of the offer. Transaction costs (we are considering payments) but also switching costs (we are considering technologies) play an important role in this setting. This dynamical model examines the properties of each possible m-payment solution.

We then derive from this setting the possible patterns of adoption of users and deduce the main conclusions of the paper. The first one (Proposition 1) is a classical result, generally observed when a technology involves externalities: for the same fundamentals, there generally exist multiple stable equilibriums, including an equilibrium of non-adoption and equilibriums of partial adoption of the new payment technology. Even if the number of possible stable equilibriums can increase with two different offers, there is no clear motive in this multiplicity that there is a specific interest to introduce different varieties of m-payment services. The second proposition (Proposition 2) is more original. It shows that when the elaborated service is offered in addition of the simplified already is available, this diversification increases the number of banked agents but does not change the total number of m-payment users. With the last proposition (Proposition 3), it appears that the symmetric property is not verified. Namely, when the elaborated service is initially offered and that the simplified service is introduced in a second time, the introduction of the simplified service increases both the number of m-payment users and overall the number of banked users. We conclude that the simultaneous offer of two kinds of services has no real interest for the diffusion of the m-payment service which is already maximum when only the simplified service is offered. Conversely, the simultaneous offer of the two varieties maximizes the number of banked agents and improves financial inclusion. This result rationalizes both the way mobile phone contributes to financial inclusion and the reason why simplified solutions, as those offered by mobile operators, are necessary to optimize and accelerate this inclusion.

Section 2 compares the penetration of banks and mobile phone and presents examples of m-payment solutions proposed in various sub-Saharan countries. Section 3 introduces the theoretical model able to analyze the forms of introduction of m-payment solutions in developing countries. Section 4 presents the main results of the model which exhibits different ways to become affiliated to the banks and high-

lights the role of the simplified solution provided the operator alone in this process of financial inclusion. This section ends up by a discussion on the incentives that a bank could use to motivate the operator to maintain two types of offers. Possibilities of extensions are proposed in the conclusive comments (section 5).

2 Mobile phone payments solutions in developing countries

The rapidity of diffusion of mobile phone over-performs the speed of diffusion of other innovations (see Jack and Suri, 2011). This statement is particularly relevant in Africa (Table 2 in the Appendix). In these countries, the number of mobile phones subscriptions has increased very rapidly from 22.9% to 89.4% between 2005 and 2013. This huge level of diffusion of mobile phone made it a relevant candidate to experiment the supply of different mobile payment services.

Mobile operators had the advantage of their installed base, able to serve as a potential reserve of early adopters. To overcome the lack of formal channels of banking transaction, the mobile phone then became a vector of financial flows through mobile payment (Chaia, Goland, Schiff, 2010, Bounie, Diminescu, François, 2013). The benefits of using a mobile phone as a payment method are multiple (Assadi and Cudi, 2011). The first of these that this technology saves time. No travel is required, the user can manage his money regardless of time and place. In addition, for mobile phones users, m-payment techniques are easy to learn and apply, even for illiterate people. Banks have cumbersome and binding procedures. In this way, an initial adoption of money payment services makes easier later registration and affiliation to the banking system. The third reason relates to transaction costs, lower than with the management of a current account when only cash is generally accepted. According to Grimes (2010), bank branches transaction costs are in average 4\$ while from the mobile device or the Internet, the same transaction costs are 0.08\$. Finally, the last motivation to use the mobile phone as a payment method is the lack of banking facilities in the area, forcing people to use informal channels. The phone offers the opportunity for people to get out of these channels and make more secure transactions. Aggarwal and Klapper (2013) define financial inclusion as “the ownership and use of a checking or savings account at a formal financial institution such as a commercial bank, microfinance institution, credit union, cooperative or post office. These services provide a safe place to keep paper money, rather than the more risky practices of keeping money in the home or with unregulated informal agents.” (Aggarwal and Klapper, 2013) Similarly, the low cost of mobile phones and the broad network coverage provided by operators make the use of cellulars a frugal innovation enabling unbanked people to access first to m-payment services, than to other financial services. In this migration, telephonic operators must collaborate. This collaborations takes the form of different solutions proposed to potential users, but also of different business models to manage the new service.

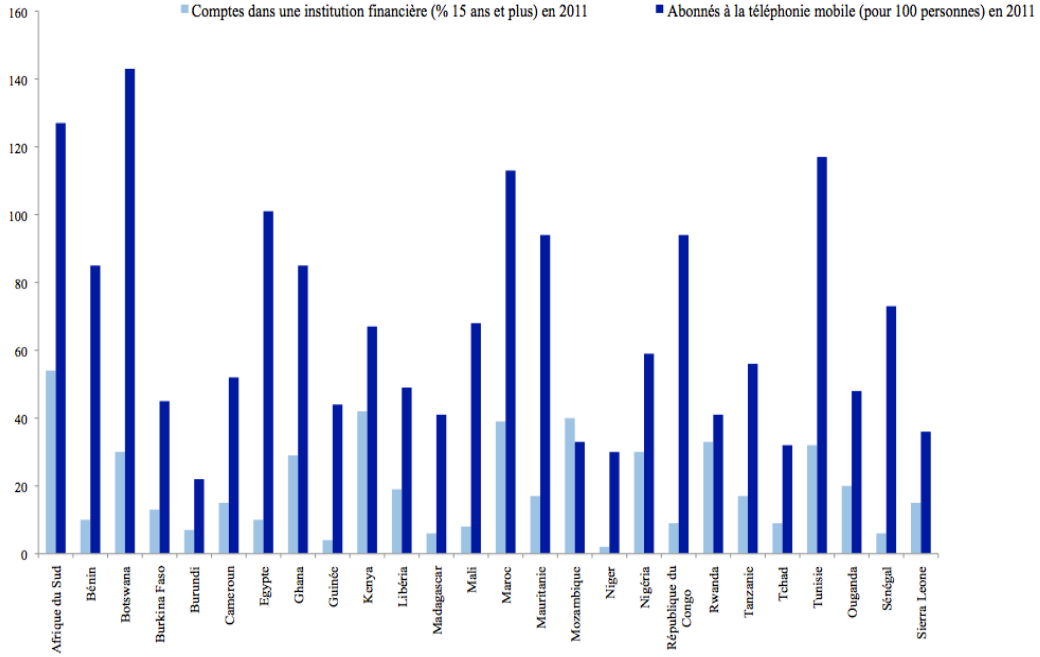


Figure 1: ICT penetration in developing countries

Many different economic models of mobile-payment have been identified in the literature (Bourreau and Verdier, 2010; Chaix, 2013). Two of them are usually proposed in developing countries:

- the operator centric model: a telephonic operator is the central node of the model, manages the transactions and distributes the property rights to partners, if any.
- the collaborative model: financial intermediaries and telephonic operators collaborate to offer and manage the service; they share cooperatively the profit generated by this service.

2.1 The operator centric solution

This m-payment solution can be illustrated by the M-Pesa case. In 2007, the mobile operator *Safaricom* launches in Kenya mobile transfer services, called *M-Pesa*. Users have access to the following services: they can make deposits and withdraw money from a network of agents, transfer money to other users and non-users, pay bills, purchase Airtime. The system is based on many certified agents who make money conversion at the demand of users. Each time a user makes a transfer, he pays a fee to the operator, depending on the amount of the transfer. Receiver is not obliged to be registered with *M-Pesa* but the transfer order will be slightly cheaper if he is. When the receiver wants to transform the digital signs that he have received into cash, he transfers his code to an intermediary (a certified agents) who is able to transforms code into cash and cash into code.

Users tend to consider this new system as a new way to access to banking and financial services. For this reason, the *M-Pesa* system has been a great success. Jack and Suri depict precisely the “Economics of M-Pesa”, *i.e.* the sequencing of adoption across households according different determinants among which income and wealth. The success of this introduction is the conjunction of many factors: transfers are almost instantaneous, simple and sufficiently safe when compared to the other possibilities. Following the success of the project, nearly a quarter of the population uses in 2012¹, *Vodafone* (British telecommunications company that owns part of *Safaricom*) decided to extend these services to new countries. M-Pesa continues its development by establishing its service in many countries (in Tanzania and Afganistan from 2008, in Romania 2014...).

2.2 Bank/operator collaborative technology:

This solution is more widespread, combining the skills of mobile operators as well as banks. *M-Pesa*, previously presented, turned to a partnership with a bank and became *M-Kesho*. *M-Kesho* is a product from *Equity Bank* in conjunction with *Safaricom* that offers *M-Pesa* customers in Kenya micro-savings, micro-credit and micro-insurance. To open a *M-Kesho* account, users must be registered *M-Pesa* subscriber and must have a Kenyan ID. To finalize subscription, users go to any *Equity Bank* brunch outlets or selected *M-Pesa* agents countrywide. The user can then choose between the two accounts in the menu of the phone depending on the desired service.

A second example of collaboration model is the partnerships initialed by the mobile operator Orange with its offers *Orange Money*, mostly in Africa. *Orange Money* is a mobile payment service available in 10 countries (Cote d’Ivoire, Senegal, Botswana, Madagascar, Mali, Niger, Cameroon, Kenya, Mauritius, Jordania). Partnerships are different on each country, for example, in Senegal, the partnership is between *La Banque Internationale pour le Commerce et l’Industrie du Sénégal*, *BICIS* owned by BNP Paribas, and Sonatel, the national network communication on Senegal, owned by Orange. The association between the bank and the operator can offer a secure and legal service related to electronic money. *BICIS* issues for instance electronic money authorized by the *Central Bank of West African States* on behalf of *Sonatel*, which is responsible for providing the mobile service, from an *Orange Money* account as a basis for each payments. Due to a still limited number of ATM machines, the system works like the mobile operator payment system, with a network of certified agents enabling to withdraw or deposit money. Interoperability is quite limited with this pilot, transfers are only available between *Orange* mobiles: this lack of interoperability is considered in this case as a possible limitation to the development of this service.

These African experiences are now reproduced in Asian countries like Afghanistan, Pakistan or India: it seems that operators and banks concentrate their effort to intervene especially in economic environments characterized by a low financial inclusion.

¹Source: Vodafone brochure: Focused on financial services for you

In India, a service called M-Paisa, was launched by Vodafone in partnership with HDFC Bank in November 2011. In these different contexts, in Africa as in Asia, fees are not used strategically by service providers, who want primarily to increase their market share. Mobile operators make it by multiplying mobile services. Thus these players develop other services that the payment by multiplying their partnerships such as micro insurance companies (Orange and NSIA in Senegal). Banks use banking services in a complementary way. The adoption of this new service allows banks to find new customers and to increase the demand for banking products (Mbiti, Weil, 2014).

In all these cases and for the moment, prices are not used strategically by service providers. Operators and banks primarily wish to increase their market share. Mobile operators then develop other services that the payment by multiplying their partnerships, for example with micro insurance services (Orange and NSIA in Senegal). Banks make use of banking services in a complementary way. In all observed cases, M-payment services adoption allows banks to attract new customers and to experiment complementary manners to increase the demand for banking products (Mbiti, Weil, 2014).

The model we present and study in the following sections aims to understand by which mechanism mobile-payment services contribute to improve financial inclusion and the style or cooperation this implies between operators and financial intermediaries.

3 The theoretical model

Our theoretical model stylizes a developing country economic environment, characterized with an incompletely developed financial intermediation but a full penetration of mobile telephony². There are three types of agents: n traders (indifferently households or firms), a telephonic operator (or a joint-venture of telephonic operators) and a bank (or a banking network).

In the initial situation, few traders are affiliated to the bank where they hold only a saving account. All traders use cash in their transactions.

3.1 Traders and payment technologies

There are n heterogeneous traders ($i = 1 \dots n$), indistinctly firms or households, uniformly distributed on the segment $[0, n]$. Each trader is initially a mobile-phone user. Mobile phone traditional services (phoning, sending and receiving SMS, taking

²Jack, Suri and Townsend (2010) recommend to use spatially segregated agents models or specific forms overlapping generation models to capture the switch from cash to mobile payments. They however do not present any original model devoted to the subject. The methodology we choose differs from their suggestions. We present an original model that differs from Townsend framework and could be considered more in line with search theoretic models tradition, by its use of switching and transaction costs, or by the nature of equilibrium positions analyzed.

photographies...) which are sufficient to justify their price. We neglect these uses and the utility that they generate. This simplification amounts to consider that the utility provided by the basic functionalities of mobile phones is the same for all traders.

At each period, trader i realizes i distant transfers or payments³. Each transfer provides her an utility u . The reservation payment technology is cash. The transaction cost f , ($f > 0$) of a distant payment in cash corresponds to fees or commissions paid by the traders to non-financial intermediaries (for instance truck drivers who are mandated to transfer cash from the payer to the payee when adequate post services are not available or adapted). This cost also includes the “self-insurance” of each payer to cover the risks associated to the physical transfer of cash. The current net utility of the unaffiliated trader i is then given by the expression (1):

$$a_i = iu - if \quad (1)$$

Affiliated traders have the same utility than other traders, with an additional amount earned as an interest on their savings. As a working assumption, we consider that the number of distant payments is proportional to their wealth or to the amount of their saving account. The instantaneous utility of bank accounts holders is then given by (2) when they make distant payments in cash:

$$b_i = iu - if + i\beta \quad (2)$$

where β figures the utility provided by saving accounts by distant payment.

As an alternative to cash payments, mobile-payment (m-payment) services are offered by the mobile operator. The m-payment technology provides basic advantages (reliability, facility of use, density of the certified agents network,...). The corresponding additional utility is q , (with $q > 0$). M-payment users pay however unitary fees p to the operator for each m-payment they realize⁴. While cash payments are accepted by all partners of a given trader, m-payments are possible only if the two partners are affiliated to the system. It is for instance impossible for a single user of the m-payment technology to obtain any utility from this use. As long as m-payment is not fully adopted, each m-payment continue to make transfers in cash when his partners are not m-payment users too. When n' represents the number of m-payment users, the instantaneous expected utility of the unbanked trader i is then given by (3):

$$c_i = iu - \left(\frac{n - n'}{n} \right) if + \frac{n'}{n} i(q - p) \quad (3)$$

³In a preliminary version of this model, we also supposed proximity payments. As this kind of payment is not concerned by the m-payment service that we consider, we have decided after the encouragements of one of the *La Revue Economique* reviewers to neglect this category of payments.

⁴We consider in this setting p as fixed. This assumption is justified by the objective of the paper which is not to analyze the role of prices as a strategic variable. Observation also attests the spectacular rigidity of fees from the beginning of the m-payment solutions introduction in East Africa and suggests that operators and banks strategic variables are varieties of services more than prices which will only become strategic when competition will dominate cooperation in the sector.

Mobile payment services can also be offered by the collaboration between the mobile operator in collaboration with a bank⁵. The instantaneous utility of the trader i is in this case given by expression (4):

$$d_i = iu - \left(\frac{n - n'}{n} \right) if + \frac{n'}{n} i(q' - p') + i\beta \quad (4)$$

The differences between c_i and d_i are (i) the advantage provided by the bank account βi , and, (ii) the level of the fees p' and of the quality q' which could differ from p and q . As interoperability operates, there is no reason to distinguish inside n' the number of traders using the service provided by the operator and the service provided cooperatively by the operator and the bank.

3.2 Switching costs

Switching/adoption costs labeled ϕ_{xy} are faced by traders to move from the payment solution x to the payment solution y . These switching costs depend both on the payment technology previously used and on the payment-technology newly adopted. When a trader uses initially cash-payments and does not hold any banking account, it is easier for him/her to adopt a m-payment technology proposed by mobile operators than the cooperative solution. In the first case, only few skills and effort are required to activate the m-payment option on the mobile-phone menu while opening an bank account includes a change in the financial habits which could deter a part of traders without banking account. When a trader is already affiliated to the bank, all things equal, it is easier for him to move directly to the cooperative solution since he has already a financial agent as partner for managing a saving account. It is also reasonable to suppose that $\phi_{bd} = \phi_{ac}$ as in each case, there is a simple switch from cash to mobile-payment, without any change concerning other financial operations or habits.

The more interesting question is then related to the level of the switching costs ϕ_{cd} to move from the m-payment services provided by the operator to the m-payment services provided in cooperation. These costs could be considered as very similar to the costs of adoption of bank services ϕ_{ab} before the introduction of mobile-payment possibilities. In each case, they correspond to the adoption of a financial environment for traders previously out of the financial intermediation system. There however exists an important difference between these two moves. Before the m-payment introduction, choosing to open a bank account is a voluntary decision which necessitates unusual actions, as entering into a bank, completing different forms, providing various informations not so easy to obtain. After the introduction of mobile-payment possibilities, the adhesion process to the bank is driven by the operator. This last can explain to customers that it is now easier and more secure to let a bank providing the liquidity to the money-payment system instead of using certified agents; the operator can also facilitate the contact between traders and financial agents, providing simplified ways to open a bank account initially devoted

⁵This is the M-Kesho case in Kenya for instance.

to transaction services, limit the number of visits of traders to bank offices... It is then reasonable to suppose that $\phi_{cd} \ll \phi_{ab}$. This inequality is critical for the results of the model. Even if there is this assumption is less critical, it is also reasonable to suppose that the cost of moving from one service of m-payment to the other is not higher than the cost of m-payment adoption, i.e. $\phi_{cd} \leq \phi_{ab}$.

The remaining comparisons can be deduced easily. For instance, the cost of adopting m-payment services in their simplified version (without the use of a banking account) is the same for all mobile phone users, banked or unbanked, which provides finally, given that $\phi_{bd} = \phi_{ac}$, the equality $\phi_{ac} = \phi_{bc} = \phi_{bd}$. Similarly, a user of the simplified m-payment system can be helped online for moving from the simplified to the advanced system, but the operator does not propose to this customer to open a banking account and to renounce to m-payment services use. It is then not easier to open a banking account without m(payment services for a user of the simplified system of m-payment than for a pure cash-user, *i.e.* $\phi_{ab} = \phi_{cb}$.

In summary, the following relations can be assumed between relevant transaction costs:

$$\phi_{cd} \leq \phi_{ac} = \phi_{bc} = \phi_{bd} < \phi_{cb} = \phi_{ab} < \phi_{ad}$$

The other moves can be considered as free from switching costs⁶. For instance, a m-payment service user can move back to the position of cash-user without incurring switching costs.

3.3 Intertemporal choices

To analyze the adoption process, we suppose that traders are fully rational and, according their position, maximize their intertemporal utilities A_i, C_i, D_i and B_i according to (i) the number of distant transfers they make, and (ii) the type of means of payment they use currently. In each four positions on the “market” of means of payment, there are then four possibilities of choices for each trader. When trader maximize their intertemporal utilities, these last then define in the following way:

$$A_i = a_i + \max \left\{ \frac{a_i}{r}, \frac{C_i}{1+r} - \phi_{ac}, \frac{D_i}{1+r} - \phi_{ad}, \frac{B_i}{1+r} - \phi_{ab} \right\} \quad (5)$$

$$C_i = c_i + \max \left\{ \frac{A_i}{1+r}, \frac{c_i}{r}, \frac{D_i}{1+r} - \phi_{cd}, \frac{B_i}{1+r} - \phi_{cb} \right\} \quad (6)$$

⁶As pointed out by one of *La Revue Economique* reviewers, ϕ_{ca} or ϕ_{da} switching costs could even be considered as negative if they involve the resale of the mobile phone. However, given that there are other uses for mobile phone (as a telephone, as a way to send SMS, to take photographs...), its resale would cut dramatically the part of instantaneous utility that we have neglected to simplify the presentation. As traders are mobile phone users when there is no m-payment service available, there is no reason that they could renounce to the basic uses of mobile phone after m-payment introduction

$$D_i = d_i + \max \left\{ \frac{A_i}{1+r}, \frac{C_i}{1+r}, \frac{d_i}{r}, \frac{B_i}{1+r} \right\} \quad (7)$$

$$B_i = b_i + \max \left\{ \frac{A_i}{1+r}, \frac{C_i}{1+r} - \phi_{bc}, \frac{D_i}{1+r} - \phi_{bd}, \frac{b_i}{r} \right\} \quad (8)$$

where r is the uniform rate of actualization and $\bar{X}_i$ is the intertemporal utility of a trader choosing to use for ever the payment technology corresponding to x .

The study of the equilibrium distribution of the means of payments among traders is now possible from equations (5) to (8) and expressions (1) to (4). Two equilibriums concepts could be used. At Nash temporary equilibrium, each trader chooses his best individual payment technology given the choices of the other traders. At stationary equilibrium, these properties are also validated with the additional condition that sub-populations and individual utilities are also stationary through time.

4 Different ways to become affiliated to the bank

The system (1) to (8) points out three determinants of m-payment adoption:

- fundamentals, *i.e.* net advantages of the mobile services over cash. These advantages depend on four factors: the amount of fees p or p' and the quality of services q or q' , the transaction costs f associated to traditional ways of transferring cash, and obviously, the number of transactions each trader makes by unit of time,
- switching costs, *i.e.* the technological and subjective obstacles to m-payment services adoption. Suppose for instance that in expressions (3) and (4), the difference between q and $(p - f)$ or q' and $(p' - f)$ are very small. Then, reasonable switching costs are sufficient to prevent the emergence of any other stationary equilibrium than the “all cash” one,
- the amount of externalities: if they are strong, *i.e.* if traders making the highest number of distant payments consider that it is not useful to adopt the m-payment when there are few users, only a “low” stationary equilibrium will probably emerge where all traders use cash. Is the effect of these negative externalities when the new technology is adopted an obstacle to its success?

These three determinants combine in the adoption process that we now analyze.

4.1 M-payment services users and cash users

From equations (1) to (8), we can analyze the temporary and stationary equilibria distribution of traders among the four possible positions, given that some of them are already affiliated to the bank before the offer of m-payment services. It is then necessary to consider the beginning of the “story”, *i.e.* the situation where all

agents use cash-payments and have to choose between holding a bank account or not, without having yet any possibility to adopt a mobile-payment solution. We could consider this situation as the benchmark model. In this initial position and for each trader i and after adequate substitutions, the choice is given by the following expression of A_i :

$$A_i = a_i + \max \left\{ \frac{a_i}{r}, \frac{b_i}{r} - \phi_{ab} \right\} \quad (9)$$

We then obtain without difficulty the following intuitive result:

Lemma 1. *When no m-payment services are available traders making the greatest number of distant payment choose to hold a bank account.*

Proof: From expression (9) in which we substitute the usual expressions $\bar{A}_i = a_i/r$ and $\bar{B}_i = b_i/r$, and from the expressions (1) and (2), we obtain that the trader i chooses to hold a bank account if $i \geq r\phi_{ab}/\beta$. Three possibilities then appear: (i) if $r\phi_{ab}/\beta$ is greater than n , no trader holds any bank account; if it is smaller or equal to 1 (which we could exclude in this environment), all traders are affiliated, and if $1 < r\phi_{ab}/\beta < n$, only a part of the population is affiliated. ■

If all traders are supposed to be initially distributed among banked and unaffiliated traders, and given Lemma 1, adoption of m-payment services begins with affiliated traders when the number of expected adopters is small, as established by lemma 2:

Lemma 2. *Whatever the values of parameters, affiliated traders are always the first to adopt m-payment technologies when n^e grows from 0 to n .*

Proof: Suppose that trader i is an unaffiliated trader adopting m-payment. Given expressions (1) to (4), the values of the switching costs and the initial conditions, expression (5) rewrites as $A_i = a_i + \max \left\{ \frac{a_i}{r}, \frac{C_i}{1+r} - \phi_{ac}, \frac{D_i}{1+r} - \phi_{ad} \right\}$. Three possibilities are then to be considered at temporary equilibrium (only two at stationary equilibrium). The first is $A_i = a_i + \frac{C_i}{1+r} - \phi_{ac}$ with $C_i = c_i + \frac{c_i}{r}$. The second is that $A_i = a_i + \frac{C_i}{1+r} - \phi_{ac}$ with $C_i = c_i + \frac{D_i}{1+r} - \phi_{cd}$ and $D_i = d_i + \frac{d_i}{r}$. The third is that $A_i = a_i + \frac{D_i}{1+r} - \phi_{ad}$ and $D_i = d_i + \frac{d_i}{r}$. If $A_i = a_i + \frac{C_i}{1+r} - \phi_{ac}$ with $C_i = c_i + \frac{c_i}{r}$, and $\frac{a_i}{r} > \frac{D_i}{1+r} - \phi_{ad}$, then, after substitutions, $i \geq \phi_{ac} / \left[\left(\frac{2n-n'}{n} \right) f + \frac{n'}{n} (q-p) \right]$. As $\phi_{bc} = \phi_{ac}$, there is only one single trader i^* such that $i^* = \phi_{ac} / \left[\left(\frac{2n-n'}{n} \right) f + \frac{n'}{n} (q-p) \right]$ and $i \geq i^*$. All affiliated traders then adopt also m-payment solutions if i adopts them ■

From the same methodology that we used to prove this lemma, it is straightforward to show that traders choose among m-payment services, according the nature of distant payments they make. The unaffiliated traders making a relative high number of distant payment have a greater propensity than others to adopt the cooperative solution if this solution has been adopted by the banked traders. Traders which adopt temporarily or definitively the solution provided by the mobile operators make an average number of payments. Cash users make a small number of payments.

4.2 Equilibrium concepts

Utilities of m-payment services users, given by expressions (3) and (4), depend on the number of m-payment users. Usually, the effective number of m-payment users n' differ from its expected number n'^e . n' is deduced from n'^e by the transformation $t(\cdot)$ which integrates and aggregates all individual decisions to provide the effective level of adoption of m-payment services as a function of its expected level. The parameters of this transformation are obviously f , q , p , q' and p' .

When adoption has already begun, we suppose that traders extrapolate from their observations, and use the current number of m-payment users to estimate their current and future utilities as m-payment users. When adoption has not begun, it is not relevant to maintain this assumption. Network innovations are generally viable only when externalities have reached a minimal level: it is of the interest of those who introduce the innovation to advertise or use other way to stimulate interest of early adopters. We then consider different cases of initial expectations and analyze the adoption process as a function of them.

As n'^e and n' generally differ, we initially consider the resting positions, *i.e.* the levels of development of m-payment services such that $n'^e = n'$. Then we consider the dynamics of adoption outside those positions.

Two different equilibrium concepts specify the possible properties of resting positions:

- A temporary equilibrium is a resting position n' ($n' = t(n')$) such that, when the effective level of m-payment adoption is n' , each trader takes the best decisions given the current choices of her partners.
- A stationary equilibrium is a temporary equilibrium which has the additional property to remain unchanged during time.

When the initial situation is a distribution of traders unbanked and banked cash users and that only equilibrium patterns and positions are considered, some moves are not relevant. For instance, in case of partial (or total) adoption of the m-payment technologies, it is impossible to observe simultaneously agents moving from the position of unbanked cash users to the position of m-payment user and other traders making the reverse transition. The remaining possible transition patterns are then illustrated by Figure 2. The circles represent the possible positions of traders and the arrows their possible equilibrium moves from one position to the other one. If for instance they use currently cash-payments without holding any bank account, they can confirm this choice for the subsequent period; they can also decide to hold a bank account, to use mobile-payments offered by the mobile operator, or by the bank/operator collaboration.

We can now prove the following lemma:

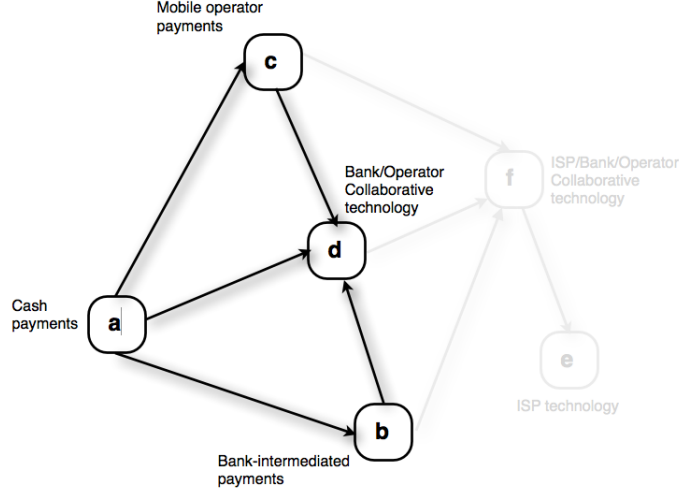


Figure 2: The transition process in developing countries

Lemma 3. *From $n^e = n^b$ such that only the trader making the highest number of distant payments chooses to use a m-payment service to $n^e = n$, n' continuously (weakly) increases with n^e .*

Proof: Given expressions (1) to (4), expressions (5) to (9) are continuous in n' (or in n^e when expected levels of adoption are considered). Still given (1) to (4), no one of these expressions decrease when n^e increases, which proves lemma (3) ■

From lemmas (2) and (3), we deduce that the transformation $t(\cdot)$ is continuous from $[0, n]$ on itself. This property is valid when we consider the first choices made by each trader when the m-payment services are offered from the benchmark situation: in this case the resting positions $n' = t(n')$ correspond to temporary equilibria. But it is also valid when repeated choices are concerned after the introduction of m-payment services. Between temporary and stationary equilibria, the difference is indeed that some traders can choose to move from the position of cash-users toward the position of m-payment services users in two steps: in the first step, they could adopt the simplified service provided by the operator alone, then, in a second step, they would move to the advanced service provided cooperatively. However, these two stage moves do not modify during the step 2 the level of adoption of m-payment services reached during step 1. Despite the distribution among m-payment service solutions change from step 1 to step 2, the final number of adopters is obtained from step 1. As a consequence, when resting positions are only defined by the number of adopters (and not by their level of utility form instance), temporary equilibria are also stationary ones. All the properties of the transformation $t(\cdot)$ valid when this transformation relates to the first choices of traders after the introduction of m-payment solutions are also valid for the when this transformation relates to their final choices. As a consequence of the contiguity of $t(\cdot)$ and of its definition from the compact $[1, n]$ on itself, we can deduce the existence of at least one temporary / stationary equilibrium for each set of parameters f, q, p, q' and p' . These equilibria can be of three styles:

- Temporary or stationary equilibriums without adoption ($0 = t(0)$)
- Temporary or stationary equilibriums with partial adoption ($n' = t(n')$, with $0 < n' < n$).
- Temporary or stationary equilibriums with full adoption ($n = t(n)$).

4.3 Temporary and stationary equilibriums

Let us consider first the full adoption occurrence. Equilibriums of full adoption exist when the switching costs of the m-payment systems ϕ_{ac} are so small that even the agent $i = 1$ who realizes only 1 distant payment feels interesting adopting m-payment services when the other traders are also adopters. Lemma 4 precises the conditions of existence of such equilibriums.

Lemma 4. *Full adoption temporary and stationary equilibriums exist if at least one of the following inequalities is verified:*

- $(q - p + f) \geq r\phi_{ac}$
- $(q' - p' + f + \beta) \geq r\phi_{ad}$

Proof: If a full adoption equilibrium exists such that the trader making one single transaction uses the m-payment service provided by the operator, given expressions (5) and (6), the following inequality holds: $\frac{a_i}{r} \leq \frac{c_i}{1+r} - \phi_{ac} + \frac{c_i}{r(1+r)}$ which, after adequate substitutions using expressions (1) and (3) with $n' = n$ provides the condition $(q - p + f) \geq r\phi_{ac}$. If a full adoption equilibrium exists such that the trader making one single transaction uses the m-payment service provided cooperatively at temporary and stationary equilibrium, given expressions (5) and (7), the following inequality holds: $\frac{a_i}{r} \leq \frac{d_i}{1+r} - \phi_{ad} + \frac{d_i}{r(1+r)}$ which, after adequate substitutions using expressions (1) and (4) with $n' = n$ provides the condition $(q' - p' + f + \beta) \geq r\phi_{ac}$. If a full adoption equilibrium exists such that the trader making one single transaction uses the m-payment service provided by the operator at temporary equilibrium and the service provided cooperatively at stationary equilibrium, given expressions (5), (5) and (7), the following inequality holds: $\frac{a_i}{r} \leq \frac{d_i}{1+r} - \phi_{ad} + \frac{d_i}{r(1+r)}$ which, after adequate substitutions using expressions (1) and (4) with $n' = n$ provides the condition $r(q - p + f + \beta) + (q' - p' + f + \beta) \geq r(1 + r)\phi_{ac} + r\phi_{ad}$ which is valid only if at least one of the two previous inequalities is also verified ■

The existence of full-adoption equilibrium is then conditioned to the respective weight of switching costs and to the intrinsic advantage $(q - p + f)$ or $(q' - p' + f + \beta)$ of m-payment over cash payment. Given that switching costs are not negligible in countries where the level of education is rather low, one can consider that lemma (4) describes conditions hardly satisfied.

Consider now the occurrence of equilibriums with no adoption. They correspond to the cases where no trader wish adopting m-payment services when nobody use them. As intuition predicts, lemma (5) prove that this kind of equilibrium exists, whatever the values of the parameters.

Lemma 5. *As soon as $\phi_{bd} > 0$, non-adoption is still a temporary and stationary equilibrium.*

Proof: The trader making the largest number of transaction is a banked agent. His intertemporal utility is given by $b_i + \frac{b_i}{r}$ if he does not adopt any m-payment service and $b_i + \frac{d_i}{(1+r)} - \phi_{bd} + \frac{d_i}{r(1+r)}$ if he subscribes to the m-payment service provided cooperatively. The expression of d_i with $n' = 0$ makes the non-adoption option the best choice, whatever the values of the parameters, as soon as $\phi_{bd} > 0$. ■

Given that the transformation $n' = t(n^e)$ is continuous on the definition interval $[0, n]$, given also that the no-adoption issue is still an equilibrium, there is potentially (except in limit cases of vanishing measure) an odd number of temporary and stationary equilibriums. Proposition 1 precises the nature of these equilibrium positions.

Proposition 1. *If full adoption of the m-payment is not an equilibrium (temporary or stationary), except in limit cases of vanishing measure, there always exists an odd number of (temporary and stationary) equilibriums. From the no-adoption equilibrium to the equilibrium corresponding to the largest number of adopters, stable and unstable equilibriums alternate. As the equilibrium of no-adoption, the equilibrium maximizing the number of adopters is also stable.*

Proof: The form of the transformation $n' = t(n^e)$ can be studied from the results of lemmas 1 to 5. For the smallest values of n^e , even the (banked) trader making the largest number of transactions does not find interesting to adopt m-payment services. From some level of expectations, let say $\underline{n}^e$, the adoption begins. The transformation $n' = t(n^e)$ has from this point the equation $n' = n - \frac{nr\phi_{bd}}{n^e(q' - p' + f)}$. The first derivative in n^e is positive and the second negative. Thus, on this portion, the transformation $n' = t(n^e)$ is a function increasing at a decreasing rate on n^e . For some level of expectations, the adoption of unbanked traders begins. From this value of n^e , the slope of the transformation $n' = t(n^e)$ becomes $\frac{nr\phi_{ad}}{n^e(q' - p' + f) + n\beta}$. The first and second derivatives are still respectively positive and negative, providing the expected variation for $n' = t(n^e)$. Then, from some level of n^e , the transformation begins to integrate two stages adoptions, with traders adopting initially the service proposed by the operator alone, then at stationary equilibrium the service proposed cooperatively. At this level the equation of $n' = t(n^e)$ becomes $n' = n - \frac{nr(\phi_{ac}(1+r) + \phi_{cd})}{(1+r)n^e(q - p + f) + \beta + \delta}$ with $\delta = (q' - p') - (q - p)$. This is still a function increasing with n^e at a decreasing rate. Then, for the highest values of n^e , the last portion of the curve corresponds to the operator centric solution adopters. The equation of the transformation then becomes $n' = n - \frac{nr\phi_{ac}}{n^e(q - p + f)}$ with still the same properties than the previous portions of the curve. According the values of parameters, transformation $n' = t(n^e)$ can then have only one fixed point ($n' = 0$) or a positive and odd number ones (see figure 4.3) ■

Figure 4.3 provides 3 cases of equilibriums. In the *case 1*, the no-adoption equilibrium is the only temporary and stationary equilibrium. With the help of arrows mimicking the use of extrapolative expectations after any initial expectations. In

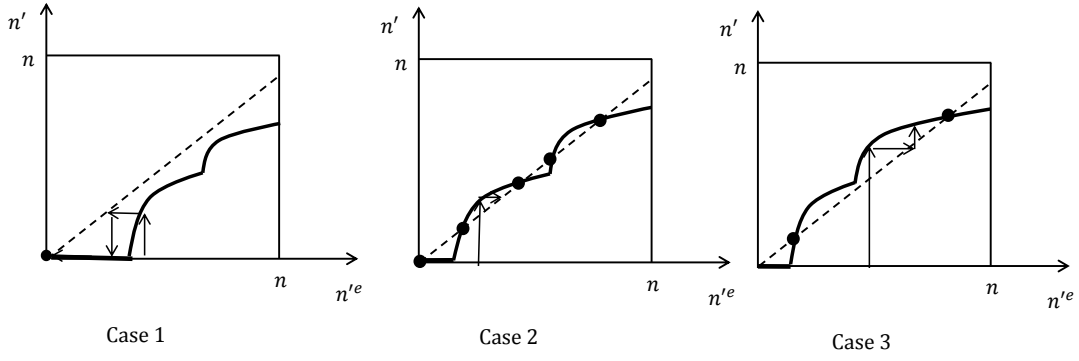


Figure 3: Single or multiple equilibriums

in this case, the switching costs are too high when compared to the intrinsic advantages of m-payment services: adoption is only transitory and the network rapidly collapses. In *case 2*, there are 5 equilibriums. Adoption equilibriums correspond to different sizes of the m-payment users network. Equilibriums 2 and 4 are unstable and equilibriums 3 and 5 are locally stable, as the equilibrium 1 of no-adoption. It is straightforward to verify that the equilibriums can be compared according to Pareto criterion. Equilibrium 5 is then locally stable and Pareto superior to the other ones. The process of adoption has however in this case a hardly predictable end as its issue depends on the initial expectations of traders. In *case 3*, there are only 3 equilibriums. The third one is stable: it corresponds to a large number of adopters. Some of them use the advanced service provided cooperatively while the others pay with the simplified service provided by the operator alone. In this case, the switching costs are sufficiently low and the intrinsic advantages of the m-payment sufficiently high to allow a successful adoption of unbanked traders.

4.4 What transition process for m-payment adopters?

This subsection considers the equilibriums pointed out in section (4.3) to analyze the way mobile-payment helps/accelerates financial inclusion in developing countries. If only the cooperative m-payment solution is offered, a part of unaffiliated traders will find it interesting to access to bank services because m-payment adds to their utility and compensates the switching costs that previously prevented the access to these services. Consider for instance *case 2* in Figure 4.3. If only the cooperative solution is provided, the third equilibrium can emerge: in this case, m-payment users integrate all traders previously banked but also agents previously unbanked but finding it interesting to join a bank because m-payment adds a utility to the traditional services of saving management.

Proposition 2 exhibits another and less trivial consequence of the introduction of the two forms of m-payment services. When the two solutions (operator centric and cooperative) are offered and both activated, the number of m-payment users at stationary equilibrium is the same as if only the cooperative solution would have

been offered. This result establishes that when the cooperative system is proposed in an environment where the operator centric solution is already offered, this new possibility generates a migration of users from the initial system to the new service, without widening the basis of m-payment users.

Proposition 2. *When a cooperative m-payment service is proposed in addition to the m-payment service initially provided by the operator alone, if the mobile operator solution remains active at stationary equilibrium, the cooperative m-payment service offer does not increase the number of m-payment service users.*

Proof: If at stationary equilibrium, before the introduction of the cooperative solution, the last adopter uses the solution provided by the operator, the number of m-payment services users is given by $n' = n - \frac{nr\phi_{ac}}{n^e(q-p+f)}$ and $n' = n'^*$. This number is also the total number of adopters when the two services are proposed simultaneously (see proof of Proposition 1). The only difference is that traders making the highest number of payments use the cooperative service when this last is available ■

Proposition 2 asserts that the intervention of banks is not necessary for the success of m-payment in poorly banked environments. However, if not necessary, this intervention is welfare improving. Even maintaining unchanged the number of users, the introduction of a more advanced cooperative service organizes the migration of some unbanked traders from one service to the other. This migration increases the utility of migrants without decreasing the satisfaction of non-migrants: it is then Pareto improving. This property can motivate public authority to encourage partners to offer and improved cooperative service. There is however even more motives for policy makers to encourage the introduction of the frugal innovation provided by the operator. Proposition 3 explains indeed the importance of the simple solution provided by the operator alone, as an help to financial inclusion. The content of this proposition could apply in Est Africa or other developing countries. If the quality and fees of the advanced service make it more advantageous in term of instantaneous utility than the simplified offer of the operator, and if switching costs dissuade one part of traders to move directly from the position of full cash users to the position of users of the m-payment service provided cooperatively, then we verify that when an operator centric simplified solution is added to the m-payment service provided cooperatively, at stationary equilibrium there are a higher number of traders affiliated to the bank than when only the elaborate solution is offered alone.

This result has a direct consequence: the mobile operator has no special interest to promote a cooperative solution, except if the new increase of its profit per trader in the cooperative setting could compensate the decrease of its share of market as an independent service provider. The situation of banks seems different: banks have obviously interest to cooperate with operators as operators provide the mobile access to new potential customers. This asymmetry provides a strong advantage to the operators in the bargaining round they can undertake with banks before concluding an agreement to provide the cooperative solution. Banks have indeed interest to cooperate, and to concede advantages to the operator.

Beyond the direct and indirect advantages that provides them the cooperative solution for banks, even the maintain of a simplified m-payment offer managed by operators alone can have an interest for banks. Proposition (3) proves it formally. The intuition is as follows: if the switching costs ϕ_{ad} are such that $\phi_{ad} > \phi_{ac} + \phi_{cd}$, it is all things equal, more interesting for an unaffiliated trader to adopt first the m-payment solution provided by the operator, then to migrate toward the cooperative solution. In the general case, the result can be proved in the following way:

Proposition 3. *If $\phi_{ad} > \phi_{ac} + \phi_{cd}$, the number of bank affiliated traders is higher at stationary equilibrium if the operator provides also its own m-payment solution than if the cooperative solution is the only available offer.*

Proof: The conditions of the proposition are the following ones: (i) the highest stationary equilibrium integrates traders having initially adopted the simplified solution, then migrated to the more advanced one; (ii) there are more banked traders at stationary equilibrium when the two m-payments services are proposed than when only the elaborated service is available. The condition (i) is for instance validated when (ia) the highest stationary equilibrium integrates unbanked m-payment users, and (ib) there exists banked users having migrated in two steps. Condition (ia) determines the total number of m-payment services adopters as the solution in n' of the equation $n' = n - \frac{rn\phi_{ac}}{n'(q-p+f)}$, i.e. $n' = \frac{n}{2} + \frac{(n^2\Delta^2 - 4nr\Delta\phi_{ac})^{1/2}}{2\Delta}$ where $\Delta = (q-p+f)$. Considering condition (ib), the threshold trader between those who migrate in two steps and unbanked m-payment users is, after few arithmetics, such that $i^* = \frac{r\phi_{cd}}{\beta}$. This threshold agent must be smaller than the threshold between unbanked m-payment users and those adopting the banked solution in one step. This last is such that $i^{**} = \frac{r(\phi_{ad}-\phi_{ac})}{\beta}$. The comparison of i^* and i^{**} provides the condition $\phi_{ad} > \phi_{ac} + \phi_{cd}$. (ii) The number of banked traders is then $n - i^* = n - \frac{r\phi_{cd}}{\beta}$. Without any simplified m-payment service, the high level equilibrium is the solution of the equation $n'' = n - \frac{rn\phi_{ad}}{n''(q-p+f)+n\beta}$ which gives the value $n'' = \frac{n(\Delta-\beta)}{2\Delta} + \frac{(n^2(\beta-\Delta)^2 - 4\Delta(n^2\beta+nr\phi_{ad}))^{1/2}}{2\Delta}$. ■

The interpretation of Proposition (3) is easy. Under the condition of proposition 3, it is in the interest of banks not only to cooperate with mobile-operators to gain new clients with the offer of the cooperative solution, but also to stimulate the parallel offer of a simplified service, accessible to unaffiliated traders. The initial adoption of this m-payment service by unaffiliated users, makes them ready to migrate to the more advanced m-payment service offered cooperatively. This migration includes the necessity to affiliate but simultaneously opens them to the traditional services offered by a bank. Finally, in the stage of m-payment services adoption, bank have more interest to cooperate than operators⁷.

⁷If there are many competitors in the telecommunication industry, each one using m-payment services and partnerships with one of all banks to increase their competitive advantage, there could be other motives to cooperative for operators. This competitive environment seems generally emerging only few years after the first introduction by the m-payment service by a pioneer operator with special relationships with a partner bank

4.5 Are there sufficient incentives for the operator to cooperate?

Propositions (2) and (3) attest that it is in the interest of the bank to cooperate with the operator while the answer is not so trivial for the operator. Cooperative initiatives must then be initiated by the bank which has interest not only to exploit the installed base of the operator, to benefit from skills and competence of its partner, but also - as proved in proposition (3) to use the simplified offer of the operator alone as a way to enlarge the number of affiliated traders. Operator could also have interest to cooperate. The gain is for them to prepare the future, to avoid that, as soon as banks have acquired the technology, they could use it to crowd out operators from an efficient offer. In all cases, under the condition of profitability, banks have interest to compensate operators inside the cooperative agreement from the profits they would have earned without the cooperative system. This profit, resulting from the only offer of the operator centric service can be expressed as (10):

$$\int_{i^{a/c}}^n (p - \theta q)i - \Theta \quad (10)$$

where θq represents the cost by payment (or variable cost) supported by the operator. This cost covers essentially the service of certified agents⁸ who transform cash into code and code into cash. By simplification, we suppose that these intermediaries receive a payment proportional to the number of conversions they make, this last being itself a linear function of the number of payments⁹. Θ corresponds to the fixed costs of research, development, infrastructure and management. $i^{a/c}$ is the adopter that makes the smallest number of distant payments.

A part of this profit is still earned at stationary equilibrium by the operator after the introduction of the cooperative offer. It corresponds to the fees paid by traders using the m-payment system at stationary equilibrium. It expresses as (11):

$$\int_{i^{a/c}}^{c/cd} (p - cq)i \quad (11)$$

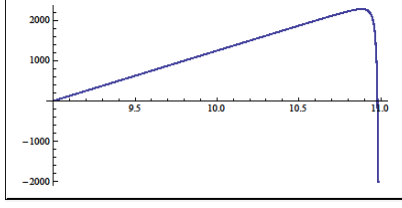
Finally, if $q - p = q' - p'$, the compensation necessary to convince operators to cooperate and to maintain simultaneously their own system is the difference between expressions (10) and (11), *i.e.* expression (12):

$$\int_{i^{c/cd}}^n (p - \theta q)i - \Theta \quad (12)$$

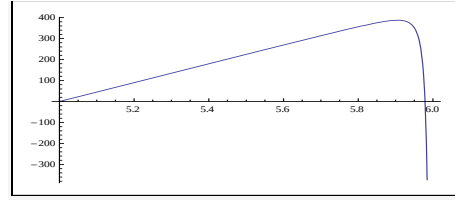
where g maximizes expression (10), *i.e.* the developed expression $\frac{(g-\theta q)n^2}{2} - \text{frac}(g - \theta q)n'^2/2$, where $n' = \max[0, \frac{n}{2} + \frac{(n^2\Delta^2 - 4nr\Delta\phi_{ac})^{1/2}}{2\Delta}]$ with $\Delta = (q - p + f)$.

⁸Certified agents are usually agents having an extended network, as post offices or other types of shopkeepers

⁹This assumption probably under-evaluates the number of conversions and the costs when there are few m-payment users and under-evaluates them when they are many.



$$q = 5, f = 5, h = 1, \theta = 9/5, r\phi_{ac} = 1$$



$$q = 8, f = 4, h = 6, \theta = 5/8, r\phi_{ac} = 0.4$$

Figure 4: Simulations of g^* and of the maximum of operators' profit when the operator centric service is the only offer.

The study of this expression¹⁰ attests that when there are adopters, there is always a price p^* which maximizes the profit of the operator. Numerical simulations of Figure 4 exhibits possible examples of values of p^* , according the amounts of relevant parameters.

5 Other assumptions and possible extensions

We have analyzed in this paper the role of mobile payment in developing countries, in an environment characterized by a low development of financial intermediation. We have tried to understand why m-payment solutions are generally successful in these country while their adoption is very limited in developed countries. With a dynamic model allowing to capture the change of uses in term of means of payment, we have obtained two types of results. We initially founded that agents making the largest number of payments are the early adopters. This result contrasts with the case of developing countries where the number of reliable means of payment provided by financial intermediaries make agents making a large number of payment few receptive to the services provided by m-payment. Mobile-payment distant services are largely redundant in banked environments while they emerge as the adequate innovation when unbanked agents dominate.

We have analyzed in this paper on the role of services provided by telephonic operators alone in developing country. With a theoretical model built on reasonable assumptions, we have tried to understand how these simplified service is able to increase the extent of m-payment users network, even when a more elaborated service is also provided cooperatively by an operator and a bank. This elaborated offer obviously improves financial inclusion, but the efficiency of the m-payment service is maximal when some adopters remain temporarily or definitively outside banks. Namely, our results establish that in an unbanked environment, the elaborated solution provided cooperatively improves the utility of some traders but does not increases the extent of the network of m-payment services users. Conversely, in the same environment, the simplified solution provided by the operator alone is able to increase the level financial inclusion already improved when only the cooperative solution is proposed to traders. We finally discuss the incentives banks could use to

¹⁰this is a continuous expression on p , expressed on the semi-positive orthant

motivate the operator both to collaborate in a joint-venture offer and to provide in parallel a simplified service.

The model presented in this paper uses simplifying assumptions. For instance, we suppose one single operator and one single bank (or a network of cooperative banks). The objective is indeed not to address issues like competition between operators or banks, in the m-payment services provision. Increasing the number of offers by different competitors should confirm the role played by m-payment services in financial inclusion, but also make less clear the exact role of partners in this process. We suppose also perfect interoperability among services, as it is the case when the same operator participates to the different offers. We could however imagine, with the development of competition among partners, that there are two (or two groups of) operator(s), the first (group) proposing the operator centric solution and the other one a collaborative solution with banks. In this case, the interoperability could be imperfect and externalities inside each network should differ from externalities among networks. We could imagine the following case. Suppose that the externalities diffused by the collaborative solution users are larger than those generated by the operator centric users (interactions are easier, or more secure when banks are associated. . .) Then, with the assumptions of Proposition (3), the “second step” move from agents “located” between $a^{c/cd}$ and $a^{cd/d}$ toward the collaborative solution will increase the general level of externalities. This increase will push new cash-payment users to adopt the operator centric solution, and some traders having previously adopted definitively the operator centric solution to switch toward the collaborative solution. The adoption process will then continue during time, with new waves of adopters, following the progressive increase of the total level of externalities. This new context then confirms the robustness of Proposition (3), even when operators are not able to collaborate fully with banks. This enriched the context would however necessitate another type of model, probably analyzed numerically.

References

- Allen, F., Carletti, E., Cull, R., Qian, J., Senbet, L., Valenzuela, P., (2012), “Improving Access to Banking: Evidence from Kenya”, Paper presented at the 2012 Summer Research Conference on *Recent Advances in Corporate Finance*, at the Centre for Analytical Finance, Indian School of Business in Hyderabad.
- Andrianaivo, M., Kpodar, K., (2011), “ICT, Financial Inclusion, and Growth: Evidence from African Countries”, *IMF Working Papers*, November 2011.
- Asian Development Bank Institute (2001), “Information and communication technology (ICT) strategies for developing countries”, *Executive Summary Series*, 21-27 February, Singapour.
- Assadi, D., Cudi, A., (2011), “Le potentiel d’inclusion financière du Mobile Banking. Une étude exploratoire”, *Management & Avenir*, n°46, pp. 227-243.
- Beshouri, C., Gravrâk, J., (2010), “Capturing the promise of mobile banking in emerging markets”, *McKinsey Quarterly*, 2010.
- Bounie D., Dimitrescu, D., François, A. (2013), “On the Effect of Mobile Phone on Migrant Remittances: A Closer Look at International Transfers”, *Electronic Commerce Research & Appli-*

cations, Vol. 12, n°3, pp. 280-288.

Bourreau, M., Verdier, M. (2010), "Cooperation for Innovation in Payment Systems: The Case of Mobile Payments", *Communication & Strategies*, Vol. 79, n°3, pp. 95-113.

Castells, M., (1996), *The Rise of the Network Society*. Vol. 1. The Information age: Economy, society and culture. Blackwell, Oxford.

Chaia, A., Goland T., Schiff, R., (2010), "Counting the world's Unbanked", *McKinsey Quarterly*.

Chaix, L., (2013), "Le paiement mobile : modèles économiques et régulation financière", *Revue d'Economie Financière*, n° 112, décembre, pp....

Chatain, P.-L., Zerzan, A., Noor, W., Dannaoui, N., de Koker, L. (2011), "Protecting mobile money against financial crimes: Global policy challenges and solutions", Washington, DC: The World Bank.

Claire, A., Mas, I., Radcliffe, D., (2010), "Regulating New Banking Models that can Bring Financial Services to All". Bill & Melinda Gates Foundation Note.

Chen, W., Wellman, B. (2004), "The global digital divide - Within and between countries", *IT&Society*, Vol. 1, n° 7, Summer, pp. 18-25.

Demirguc-Kunt, A., Klapper, L. (2012), "Measuring Financial Inclusion. The Global Findex Database", The World Bank, Development Research Group, Finance and Private Sector Development Team, April.

De Sousa, S., (2010), "The role of payment systems in reaching the Unbanked", *Journal of Payments Strategy and Systems*, Vol. 4, n° 2, pp. 148-155.

Dupas, P., Keats, A., Green, S., Robinson, J., (2011), "Supply and Demand Challenges in Banking the Rural Poor, Evidence from Kenya", *NBER Project on African Successes*, working paper.

Gaiani, S., (2008), "Information and Communication Technologies (ICTs) for Rural Development in Developing Countries", *New Medit: Mediterranean Journal of Economics, Agriculture and Environment*, March, Vol. 7, n° 1, pp. 50-57.

Guerin, I., Roesch, M., Morvant-Roux, S., Fouillet, C., Hillenkamp, I., (2007), "La microfinance aujourd'hui : une utilité incontestable mais des effets mitigés en matière de lutte contre la pauvreté et les inégalités", *Annuaire Suisse du Développement*, Vol. 26, pp.103-121.

Hardy, A., (1980), "The role of the telephone in economic development", *Telecommunications Policy*, Vol. 4, n° 4, pp. 278-286.

Jack, W., Suri, T., (2011), "Mobile Money: The Economics of M-PESA", National Bureau of Economic Research, *NBER Working Papers*: 16721.

Jack, W., Suri, T., Townsend, R., (2010), "Monetary Theory and Electronic Money: Reflections on the Kenyan Experience", *Economic Quarterly*, Vol. 96, n° 1, First Quarter, pp. 83-122.

Koker, L., Jentzsch, N., (2013), "Financial Inclusion and Financial integrity: Aligned Incentives?", *World development*, Vol. 44, pp. 267-280.

Loo, B.P.Y., Ngan, Y.L. (2012), "Developing Mobile Telecommunications to Narrow Digital Divide in Developing Countries? Some Lessons from China", *Telecommunications Policy*, Nov-Dec, Vol. 36, n° 10-11, pp. 888-900

Lyons, A., Scherpf, E., (2004), "Moving from unbanked to banked : evidence from the Money Start Program", *Financial Services Review*, Vol. 13, pp. 215-231.

Mbiti, I., Weil, D.N., (2014), "Mobile banking: the impact of M-Pesa in Kenya", National Bureau of Economic Research, *NBER Working Papers*: 17129.

Morvant-Roux S., Guérin, I., Servet, J-M., (2010), "Politiques d'inclusion financière, microfinance et financement de l'agriculture : Les cas de l'Inde et du Mexique", *Mondes en développement*, Vol. 3, n° 151, pp. 9-24.

Ondrus J., Pigneur Y., (2006), "Towards A Holistic Analysis of Mobile Payments: A Multiple Perspectives Approach", *Electronic Commerce and Research Applications*, Vol. 5, n° 3.

Pickens, M., Porteous, D., Rotman, S., (2009), Scenarios for branchless banking. Focus Note 57. Washington, DC: CGAP

Roller, L.H., Waverman, L., (2001), "Telecommunications infrastructure and economic development: A simultaneous approach", *American Economic Review* Vol. 91, n° 4: pp. 909-923.

Souter, D., (2004), "Partie I : Les TIC et la croissance économique dans les pays en développement", *Revue de l'OCDE sur le développement* , Vol. 4, n° 5, pp. 1-7.

Steinmueller, E., (2001), "ICT and the possibilities for leapfrogging in developing countries", *International Labour Review*, Vol. 140, n° 2, pp. 193-210.

William, J., Tavneet, S., (2011), *Mobile money: the economics of m-pesa*, NBER Working Paper No. 16721, January.

Wonglimpiyarat, J., (2014), "Competition and challenges of mobile banking: A systematic review of major bank models in the Thai banking industry", *The Journal of High Technology Management Research*, Volume 25, Issue 2, 2014, pp. 123-131.

World Bank (2012), "Innovations in Retail Payments Worldwide: A Snapshot", World Bank: Washington, DC.

Appendix: Penetration of ICT and financial inclusion according the level of income

	2011		2012					2013							
	Low income ^{e1}	Lower middle income ^{e2}	High income nonOECD ^{a3}	High income OECD ^{d4}	Upper middle income ^{e5}	Low income	Lower middle income	High income nonOECD	High income OECD	Upper middle income	Low income	Lower middle income	High income nonOECD	High income OECD	Upper middle income
Automated teller machines (per 100,000 adults)	3.45	17.39	34.75	99.11	59.95	4.39	20.16	34.24	78.06	52.89					
Commercial bank branches (per 100,000 adults)	3.21	12.35	13.86	34.57	24.46	3.95	12.76	13.54	32.75	24.25					
Fixed broadband Internet subscribers (per 100 people)	1.8	78.92	14.16	27.42	14.20	0.12	84.03	14.57	28.29	15.01	0.15	87.18	17.39	29.15	15.86
Mobile cellular subscriptions (per 100 people)	44.23	1.74	100.79	119.22	109.10	51.53	1.98	108.38	121.91	112.41	58.55	2.29	110.83	122.13	115.40

Table 2: ICT penetration and financial inclusion according income level.
World Bank from data base: World development indicators, 2014.

Afghanistan, Bangladesh, Benin, Burkina Faso, Burundi, Cambodia, Central Africa Republic, Chad, Comoros, Congo Dem. Rep., Kyrgyz Republic, Madagascar, Malawi, Mali, Mozambique, Myanmar, Nepal, Niger, Rwanda, Sierra Leone, Somalia, South Sudan, Tajikistan, Tanzania, Togo, Uganda, Zimbabwe.

Armenia, Bhutan, Bolivia, Cameroon, Cape Verde, Congo Rep., Côte d'Ivoire, Djibouti, Egypt, El Salvador, Georgia, Ghana, Guatemala, Guyana, Honduras, India, Indonesia, Kiribati, Kosovo, Lao PDR, Lesotho, Mauritania, Micronesia, Moldova, Mongolia, Morocco, Nicaragua, Nigeria, Pakistan, Papua New Guinea, Paraguay, Philippines, Samoa, Sao Tome and Principe, Senegal, Solomon Islands, Sri Lanka, Sudan, Swaziland, Syrian Arab Republic, Timor-Leste, Ukraine, Uzbekistan, Vanuatu, Venezuela, West Bank and Gaza, Yemen Rep., Zambia

Andorra, Antigua and Barbuda, Aruba, Bahamas, Bahrain, Barbados, Bermuda, Brunei Darussalam, Channel Islands, Cayman Islands, Croatia, Curacao, Cyprus, Equatorial Guinea, Faeroe Islands, French Polynesia, Greenland, Guam, Hong Kong, China, Isle of Man, Kuwait, Latvia, Liechtenstein, Lithuania, Macao, SAR, China, Maldives, Monaco, New Caledonia, Northern Mariana Islands, Oman, Puerto Rico, Qatar, Russian Federation, San Marino, Saudi Arabia, Singapore, Sint Maarten (Dutch part), Sri Lanka, St. Kitts and Nevis, St. Martin (French part), Trinidad and Tobago, Turks and Caicos Islands, United Arab Emirates, Uruguay, Virgin Islands (U.S.).

Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, Rep., Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States.

Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Ecuador, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, Rep., Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, United Kingdom, Uruguay, Venezuela, Viet Nam, Yugoslavia

Brazil, Bulgaria, China, Colombia, Costa Rica, Cuba, Cyprus, Dominican Republic, Ecuador, FI, Gabon, Georgia, Hungary, Iran, Islamic Rep., Iraq, Jamaica, Jordan, Kazakhstan, Lebanon, Uzb., Macedonia, MY, Malaysia, Mexico, Morocco, Myanmar, Nepal, Nicaragua, Pakistan, Panama, Peru, Romania, Serbia, South Africa, Sri Lanka, SV, Vincent and the Grenadines, Zimbabwe

China, Hong Kong, India, Indonesia, Israel, Italy, Japan, Korea, Rep., Laos, Latvia, Lithuania, Luxembourg, Macao, Madagascar, Maldives, Marshall Islands, Mauritius, Mongolia, Montenegro, Nauru, Papua New Guinea, Philippines, Singapore, Slovenia, South Korea, Sri Lanka, SV, Taiwan, Tajikistan, Thailand, Timor-Leste, Trinidad and Tobago, Turkmenistan, Tuvalu

DOCUMENTS DE TRAVAIL GREDEG PARUS EN 2015
GREDEG Working Papers Released in 2015

2015-01

LAETITIA CHAIX & DOMINIQUE TORRE

The Dual Role of Mobile Payment in Developing Countries