Heterogeneous Credit Constraints and Smallholder Farming in Senegal

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October 20, 2017

Abstract

Credit constraints are among key challenges to unlocking the great economic and social potentials of small farm agriculture in sub-Saharan Africa. This research sets out to analyze the extent to which farmers are credit-constrained, the underlying generating mechanisms, and how financial inclusion through the reduction or elimination of credit constraints would benefit smallholders in the specific agro-ecological region of the Senegal River Valley. So far the literature tends to focus on credit applicants when defining access to credit dummy, ignoring in the process the vast majority of farmers who stay out of the market. Instead, the paper recognizes that credit constraints come in different forms to the extent that they translate into market entry barriers at the pre-application stage (ex-ante) or contribute to deteriorate the credit profile at the post-application stage (ex-post). Farm-level data are used, and a model that controls for both endogeneity and farmers' self-selection into the credit market is developed. The results suggest that credit constraints, mostly originated from high transaction costs and high risk, are harming farmers' performance, and access to credit leads to increased yields and labor productivity. The extent of the gains depends on the stage at which the constraints manifest themselves, as well as the performance indicator and the reference group. These results suggest various policy options to be considered in order to unlock the economic and social potentials associated with financial inclusion in the farming sector.

JEL Codes: D82, O13, O16.
Keywords: Credit constraints; Productivity; Yields; Switching regression; Senegal River Valley.

Acknowledgement: The author is grateful to the African Economic Research Consortium (AERC) for providing valuable financial support, as part of a collaborative research project on "Financial Sector Development and Financial Inclusion in Africa". Usual disclaimer applies.

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I. Introduction

In Senegal, as in many sub-Saharan African countries, agriculture is rightfully associated with great potentials for improving social and economic conditions of the general population, especially rural poor. Still, its actual contribution to the general dynamics of the economy and living standards is being held back by a relatively low productivity. In effect, the sector occupies more than half of the labor force and it accounts for a meager 14.8 percent of gross domestic product (GDP).[2] This is one the main features of the country's agricultural sector in which the average farmer is more than six times less productive than her counterpart in the rest of the economy.

The low productivity of the sector greatly contrasts with its unrivaled potentials for improving economic and social conditions. In effect, a productive agricultural activity would contribute to resorb the enormous food gaps that mainly originate from low domestic production relative to the ever-increasing demand. In addition, by increasing the domestic components of the food markets and reducing the structural dependence on imports, greater productivity in agriculture would help reduce the vulnerability to foreign shocks, particularly those related to prices. It would also help improve food security by increasing the availability of agricultural products, as well as their affordability, thanks in part to more favorable price dynamics. Furthermore, it would provide increased income and economic opportunities to a large majority of the population that depends directly or indirectly on the sector for their livelihood, particularly in the rural sector, thereby reducing poverty and inequality.

Overcoming the many hurdles in the credit market could be one way to improve farmers' productivity. In effect, in an ideal world of perfect and complete markets, access to credit spells a possibility to expand the production possibilities through greater capital accumulation, be it physical or technological. Farmers could therefore reach more efficient combinations of productive inputs, allowing them to produce greater output for any given input cost. Furthermore, an increase in the production possibilities made possible by a greater access to finance can contribute to lower the average cost, especially in the context of increasing returns to scale. This is synonymous with firms' ability to minimize their input usage to reach a given level of output. To the extent that a farming activity might be constrained in the credit market, all of these efficiency gains could be unreachable.

Among the many factors that have been preventing these economic and social potentials to fully materialize are credit constraints. Many farmers, especially smallholders, remain financially excluded. The survey data that will be used in this research suggest that over six out of ten farmers (63 percent) do not have access to credit, be it in the formal market (from banks) or in the semi-formal credit market (from microfinance institutions, government agencies or non-government organizations). This is suggestive of a financial exclusion for a large majority of farmers.

While the theoretical literature has provided various frameworks that help understand the functioning of the credit market (see for instance McKinnon, 1973; Shaw, 1973; Stiglitz and Weiss, 1983; Bell, 1988), the empirical literature tends to be less conclusive when it comes to the true generating mechanisms of the various credit market outcomes as well as their contributions to farming activities (see Nwaru and Onuoha, 2010; Khan *et al*., 2013; Diagne and Zeller, 2001, among others).

[2] Ministry of Agriculture and Rural Equipment of Senegal, and World Development Indicators Online.

It is very likely that the great deal of heterogeneity in the results has to do with various specificities both in the functioning of the credit market as well as in the agro-ecological profile and crop portfolio of countries. This makes any generalization of specific results relatively difficult, and of little help to the design of public policies aiming at improving the functioning of the domestic credit market and its contribution to agricultural performance. This is very true for countries that have not been a focus of any empirical research, such as Senegal, that would have documented how credit constraints play out both in terms of their generating mechanisms and their consequences on agricultural performance.

This research aims to analyze the relationship between credit markets and farming activities in Senegal. More specifically, it tries to determine the extent to which farmers, especially smallholders, are credit-constrained, the generating mechanisms, and how the lack of access to credit is potentially harming their performance. We posit that (i) credit constraints are holding back farmers' productivity, and financial inclusion in the form of extending credit to constrained farmers leads to improved agricultural performance, and (ii) not all forms of credit constraints have the same generating mechanisms (depending on whether they prevent farmers participating into the credit market or whether they end up into application rejection), nor have they the same impact on agricultural productivity.

The paper adds to the general literature by accounting for the various types of credit constraints, instead of just pooling them, and by focusing on the specific agro-ecological region of the Senegal River Valley. The region has been the focus of a consistent public investment in infrastructure (road and dams, among others). The proximity of the River has always been synonymous with great irrigation potentials in this otherwise arid region located the vicinity of the Saharan desert, with only 300 mm of rain yearly, the lowest compared to any other agro-ecological region of the country that depends to a far larger extent on rain. The attractiveness of the region has led to the development of a wide range of extension services of the likes of agricultural research, technical support, financial services, public storage facilities, as well as various linkages to extended supply chains (processing industries and market distribution). This research can provide a good understanding on how these unique features would contribute to shape the credit market outcome and its translation into farmers' performance.

When it comes to financial inclusion in the form of access to credit, the widely used dichotomous approach of distinguishing between constrained and unconstrained farmers often fails to accurately portray the heterogeneity of the credit profile of farmers. By pooling credit-constrained farmers, this approach amounts to hypothesizing that the generating mechanisms of the market outcomes are similar, and this is barely the case. Recent approaches have accounted for various types of credit constraints. For instance, Ali *et al*. (2014) have suggested a distinction among transaction costs (when the application procedure is so burdensome that it deters potential borrowers from applying for a loan), price (when interest rates are too high), risk (when farmers do not apply because of a fear to lose the collateral), and quantity (when a successful applicant does not obtain the desired amount).

It can be argued that all of these types of constraints are not independent of each other. For instance, a greater risk perception may lead to more collateral requirement or translates into high interest rates, further limiting access to credit. In addition, lack of adequate collateral can also lead to high interest rate, with similar outcome. This paper goes one step further, by considering the

stage of the application process at which each constraint is more likely to manifest itself. More specification we consider the initial phase during which farmers decide whether to apply for credit or not (namely, whether to enter the market or not). Some farmers may be deterred from applying by the complicated application process or a lack of collaterals (transaction-cost constraints), or by high borrowing costs (price constraints), or the level of risk involved and which translates into the fear of losing the collaterals (risk constraints). The second stage focuses on farmers who end up applying for credit. Some of them may be quantity-constrained because inadequate collaterals or insufficient returns do not match the requested amount.

We acknowledge that some constraints could well materialize at both stages. For instance, as far as price constraint is concerned, too high an interest can keep some farmers out of the market (pre-application or ex-ante constraint). For some applicants, high interest rates could mean smaller loan application as to reduce the total credit cost (post-application or ex-post constraint). However, we argue that both the incidence and the final outcome, as well as the impact on the farming activities, are different depending on the stage at which credit constraints play out, which makes the categorization still relevant. In addition, considering these two series of credit constraints has the advantage of focusing on the various stages of the demand process: a pre-application stage (whether to apply for credit or not), and a post-application stage (whether the application is successful or not). Furthermore, such a categorization offers a clear basis for policies aiming at improving financial inclusion: how to dismantle the credit market barriers so that farmers could enter the market; and once they enter, how to make their application successful. Another advantage is statistical, as the sample size that is not too large may not allow a meaningful comparison among a large number of detailed credit constraint categories.

The empirical approach is based on a switching regression model that relates farmers' performance (alternatively output per hectare and output per worker) to credit constraint (all types combined first, and then constraints that prevent an application, and constraints that lead to unsuccessful application outcomes), as well as to a host of controls. The modeling approach has the advantage of correcting for endogeneity as well as self-selection biases, as some unobserved factors may well affect both performance and access to credit on one hand, and the prospects of increased performance may well drive farmers to seek credit on the other hand. The model is regressed using farm-level data collected in the Senegal River Valley.

The results suggest that credit constraints are indeed holding back farmers' performance, as improved access to credit contributes to raise farmers' performance, both in terms of yields and in terms of output per worker. In turn, increased farming performance is found to significantly improve the financial attractiveness of farmers, suggesting some form of virtuous circle of high productivity and financial inclusion for credit beneficiaries (and a vicious circle of low productivity and financial exclusion). The results also point to a great deal of heterogeneity, as the extent of the gains associated with greater access to credit tends to depend upon the measure of performance, the type of credit constraints and the stage at which they materialize, as well as whether one considers the gains that accrue to actual credit beneficiaries or the potential benefits to constrained farmers were they to become credit-unconstrained.

The rest of the paper unfolds as follows. Section 2 describes the study context. Section 3 briefly discusses the relevant literature. Section 4 details the methodology. Section 5 introduces the data

and some descriptive analysis. Section 6 presents and discusses the estimation results. Finally, section 7 offers some concluding remarks.

II. Study context

When it comes to the general profile of the agricultural sector, Senegal tends to be no different from the average sub-Sahara Africa country. The sector employ more than half of the labor force, provides livelihoods either directly or indirectly to about two-thirds of the population, and contributes to less than 15 percent of GDP. The Senegal River Valley (SRV), located in the northern and north-eastern part of the country, stands out as a unique agro-ecological zone. The proximity of the river spells relatively large potentials for irrigation and less reliance on rainfall that is very volatile and far from meeting the agricultural needs (the yearly average is 300 millimeters, against 1800 in the south of the country). The government focus on this region has been materialized by the establishment in 1964 of an agency that is tasked to develop hydro-agricultural infrastructure and to provide various agricultural extension services to farmers, such as technical assistance and research.[3] As a result of these sustained public efforts and the possibility to harvest a large variety of crops up to three times a year, the area is a major contributor to food and agricultural production, with for instance 70 percent of the country's rice production (Colen *et al.*, 2013) and the majority of the country's production of onions and tomatoes.[4]

However, the predominance of small family farming activities and the lack of sufficient market integration have meant that the financial sector tends to be less attracted towards the sector. Until recently, only one major bank, namely the National Bank for Agricultural Funds, has been operating in the agricultural sector.[5] It is the main provider of credit (volume-wise), mostly because of the involvement of the government that has been subsidizing the interest rates at a rate of 50 percent and the SAED that provides a technical assessment of credit applications.[6]

The modernization of the agricultural activities and better market prospects associated with the ever increasing demand for domestically produced crops as a result of government's ambitions to reach self-sufficiency have made the agricultural sector more and more attractive, and new financial actors have emerged. Microfinance institutions, with services that tend to better fit the smallholder farming needs (amount, procedures, etc.), have been gaining a significant proportion of the credit market. In addition to providing credit, their financial services include saving and money transfers. Despite their large number, only a few tend to emerge, namely *Crédit Mutuel du Senegal* (CMS), *Alliance de Crédit pour l'Epargne et le Crédit à la Production* (ACEP), and *Union pour la Mobilisation de l'Epargne et du Crédit* (UM-PAMECAS). The small scale of their loan schemes and the ease with which they can deploy to remote areas have made these institutions relatively attractive, but the interest rates they charge (could go up to 24 percent) as a result of the high cost of resource mobilization (mostly from regular banks) are far higher than those charged by the CNCAS or even other banks to non-agricultural activities. As a result, financial inclusion has remained a great challenge in the agricultural sector and rural areas.

[3] *Société Nationale d'Aménagement des Eaux du Fleuve Sénégal et des Vallées du Fleuve Sénégal et de la Falémé* – SAED (see http://www.saed.sn/Presentations.html for a detailed description; accessed in September 2017).
[4] Source: *Direction of Horticulture, Ministry of Agriculture and Rural Equipment of Senegal*.
[5] *Caisse Nationale de Crédit Agricole du Sénégal* – CNCAS.
[6] For a typical credit used in the production, the subsidized interest rate is 7.5 percent.

Recent innovations in the financial sector include some partnerships between the government and microfinance institution, with the aim of combining the benefits of the two (lower costs as a result of subsidy from the perspective of government-affiliated institution, and adequate financial services from the microfinance institutions' perspective). For instance, an institution set up by the government with the aim of accompanying investor in their credit application has set up a scheme through which it provides funding to a micro-finance institution at lower cost.[7] In return, the funds are directed to farmers, especially female and young entrepreneurs, at interest rates no greater than 12 percent. These schemes are in their infancy, and need to be expanded and improved, most notably when it comes to the selection of farmers that is not always rigorous.

III. Brief literature review

Conceptually, financial constraints originate in various sources. Traditionally, there was a focus in the literature on the supply side with the view that credit constraints were primarily involuntary (McKinnon, 1973; Shaw, 1973). Quantity rationing is a result of either policy-induced interest rate restriction in the context of information asymmetries and enforcement problems (Stiglitz and Weiss, 1983; Bell, 1988), or borrowers' inability to meet collateral requirements (Boucher *et al*., 2009). More recent studies have suggested that credit rationing could be voluntary. Transaction costs in the forms of loan application preparation, collateral value evaluation, or credit use monitoring could add to the overall cost of borrowing, leading to a wedge between effective interest rates and contracted interest rates. In addition, the risk of losing the collaterals may be too high for the borrowers. In both instances, the latter could simply stay out of the credit market even when the market rates are favorable to their projects (Carter, 1988).

There is a wide body of existing theoretical literature that conceptually provides a clear understanding of the negative impacts of credit constraints on economic development (see for instance Eswaran and Kotwal, 1986, Carter, 1988). Some studies have derived quite interesting testable relationships between credit constraints and agricultural performance, using mostly the standard agricultural household framework that combines both consumption and production decisions of farm households (de Janvry *et al*., 1991). For instance, faced with credit constraints, farmers' decisions to produce and consume are not separable, and the intensity of input use are dependent on the availability of capital and initial endowments. Therefore, farmers who are credit constrained tend to operate at sub-optimal levels by using fewer inputs, which translate into lower productivity, income, and welfare. Moreover, in the presence of market imperfections, land endowments and productivity tend to be negatively correlated, while agricultural performance (i.e., yield) tends to be positively correlated with access to liquidity and endowment of other resources such as family labor (see for instance Guirkinger and Boucher, 2008).

Still, existing empirical evidence seems relatively ambiguous (Ali *et al*., 2014). For instance, In Nigeria, Nwaru and Onuoha (2010) suggest that credit does not contribute to increase farm productivity. They even find that farmers who benefit from credit tend to be less efficient than those who do not, which could be indicative of inappropriate loans schemes. In Malawi, access to microfinance is found not to have a significant impact on net crop income (Diagne and Zeller, 2001). Khan *et al*. (2013) suggest similar results for Pakistani farmers: credit beneficiaries do not appear to be more productive or enjoy higher income than their counterparts. Some of the hypothesized

[7] *Fonds de Garantie des Investissements Prioritaires* – FONGIP.

reasons have to do with “high interest rates, delays in credit disbursement and lengthy procedure of getting credit” (p. 1).

Evidence of a positive association between access to credit and farm performance includes Foltz (2004) who suggests that credit constraints affect profitability and technology adoption in Tunisia, or Guirkinger and Boucher (2008) who indicate that elimination of credit constraint can potentially increase output by between 15 and 32 percent in Peru, or Ali *et al*. (2014) whose estimation of the impact of greater liquidity access is an increase in yields by 17 percentage points in Rwanda. Additional evidence of a positive relationship between access to credit and farm productivity includes Akudugu (2016) for Ghana and Kashif *et al*. (2016) for Pakistan, among others.

The inconclusiveness of the empirical literature may well owe to the large differences in the socio-economic setting and agricultural endowments that shape the farming activities across countries, on one hand, and to the level of maturity of the financial sector and its ability to manage risk inherent to small farming, on the other hand. Accounting for such specificities and the way they shape the interaction between farming and the credit market is a significant step toward improving financial inclusion as far as the agricultural and rural sector is concerned.

IV. Methodology

To answer the questions of what drives the likelihood that a farmer is credit-constrained and how it translates into productivity, a two-stage endogenous switching regression (ESR) model is considered. The first stage models the probability that a farmer is credit constrained, while the second stage relates performance to access to credit by comparing farmers with and without access to credit. This empirical framework combines two potential characteristics of the interaction between farmers' decisions to apply and eventually obtain credit and the associated outcome of the farming activity, namely endogeneity of and self-selectivity (Maddala and Nelson, 1975). In effect, it is assumed that the propensity to apply for and access to credit is endogenous to farmers' productivity, and some unobserved characteristics may well affect both the probability of being credit-constrained and productivity. In addition, the prospects of gaining from credit in terms of increased capacity and performance could well be a driver to farmers’ likelihood to enter the market and seek credit. Neglecting these issues, as a regular OLS estimation would do, could lead to biased and inconsistent estimates.

The ESR model, referred to as Tobit type-5 model (Amemiya, 1985), provides a correction for the self-selectivity as well as the endogeneity by explicitly modeling the interdependence between the efficiency equation for credit constrained farmers and unconstrained farmers on one hand, and the access to credit equation on the other hand. Suppose the following binary switching equation that sorts individual farmers into two regimes, based on their credit constraint status: those that have access to credit (regime 1), and those that do not (regime 0):

$$c_i = \begin{cases} 1 \; if \; c_i^* = \delta' X_i + \theta' Z_i + \mu_i > 0 \\ 0 \; if \; c_i^* = \delta' X_i + \theta' Z_i + \mu_i \leq 0 \end{cases} \quad (1)$$

c_i is the observed status of farmer *i* in the credit market, and $c_i = 1$ if the latent process captured by c_i^* is greater than the normalized threshold of 0, which is for farmers who are not credit-constrained.

X_i is a vector of explanatory variables that traditionally include the characteristics of farmers and the farming activities (gender, age, education, experience, land size, land ownership, type of crop, affiliation to farmers' organization, etc.).[8] Various studies have shown the importance of these factors as explanations of access to credit and agricultural productivity. For instance, there is a long and ongoing debate over the importance of land size and productivity (see Nkonde et al, 2015); the role of social and professional networks has also been intensively investigated (see for instance Abay *et al*., 2017, for Ethiopia); and Beaman *et al*. (2014) have stressed the role of various factors affecting access to credit as opposed to grants and their corresponding returns in Mali.

Z_i is a vector of instruments that have no impact on performance except through access to credit. One potential instrument is the average access rate in the geographical location. By definition, a simple measure of the likelihood that a randomly selected farmer in a given location is not credit-constrained is the access ratio, and it is a good predictor of c_i, while having no direct impact on the farmer's performance. Given that the data contain only few locations (3 rural communities and 7 *quartiers* in total), we add a second layer so as to o obtain a greater variation, namely crops. The instrument then become the share of unconstrained farmers in the given *quartier* and cultivating a similar crop. δ and θ are vectors of parameters to be estimated, and μ_i an error term.

The selection equation is coupled with the outcome equation which is specified as follows:

$$y_i = \begin{cases} y_{1i} = \beta_1' X_{1i} + \varepsilon_{1i} \; if \; c_i = 1 \\ y_{0i} = \beta_0' X_{0i} + \varepsilon_{0i} \; if \; c_i = 0 \end{cases} \quad (2)$$

y_i is a measure of performance of farmer *i*. It is alternatively yields (output per unit of land used) and labor productivity (output per workers). ε_{1i} and ε_{0i} are error terms.

The issues of endogeneity and self-selection are translated into a correlation between the error term in the selection equation and the error terms in the outcome equations. Some studies have estimated parameters in equations (1) and (2) separately (for instance Carter, 1989, and Guirkinger and Boucher, 2008), resulting very likely in inconsistent estimates. Following the insights by Wooldridge (2010) and Green (2008) who suggested that estimating the selection and outcome equations simultaneously with the Full Information Maximum Likelihood (FIML) method leads to consistent estimates, provided that there are no specification errors, some studies have followed this route. Ali *et al*. (2014) for instance have used this method to evaluate the impact of credit constraints on agricultural productivity and rural nonfarm participation in Rwanda. Like these authors, we will use this estimation technique, and tell how the Senegalese context translates into the explanatory power of various factors commonly used as drivers of access to credit and farming activity. Unlike the authors, we fully exploit the ability of the model to allow for heterogeneity in the results. In the outcome equation, each explanatory variable is implicitly interacted with access to credit, and the corresponding coefficient estimate is indicative of a conditional marginal effect of the explanatory variable on productivity. For instance, a significant coefficient estimate on land size would tell that credit constraints have either greater or lower impact on productivity for small farmers as opposed to their large-scale counterparts. Such a reading of the results could be very helpful for the design of better targeted public policies.

[8] A detailed listing of the variables and their definition and specification are provided in the annex.

The error terms μ_i, ε_{1i} and ε_{0i} are assumed to be normally distributed with a zero-mean and a variance-covariance matrix defined as follows:

$$\Omega = \begin{bmatrix} \sigma_u^2 & \sigma_{1u} & \sigma_{0u} \\ \sigma_{1u} & \sigma_1^2 & . \\ \sigma_{0u} & . & \sigma_0^2 \end{bmatrix}$$

σ_u^2, σ_1^2, and σ_0^2 are respectively the variances of the error terms μ_k in the discrete (selection) equation and ε_{1k} and ε_{0k} in the continuous (performance) equations. σ_{1u} and σ_{0u} are the covariances between μ_k and ε_{1k} and between μ_k and ε_{0k} respectively. Since any given farmer's performance is not observed simultaneously in both regimes, the covariance between ε_{1k} and ε_{0k} is therefore not defined, hence the dots in the matrix (see Maddala, 1983).

It comes the following correlation coefficients between μ_i and ε_{ji} (j = 1,0):

$$\rho_j = \sigma_{ju}^2 / \sigma_j \sigma_u$$

ρ_1 tells how access to credit contributes to the performance of credit beneficiaries, while ρ_0 indicates how credit would have affected credit-constrained farmers were that to access credit. A negative ρ_1 and a positive ρ_0 would indicate a positive impact of access to credit on performance, and the opposite a negative impact. The magnitude of the impacts is obtained through the model conditional predictions of the outcome variable. The ESR model can be viewed as one of the regression-based impact evaluation approaches. Access to credit is viewed a treatment process through which benefitting farmers (the treated group) manage to circumvent the many constraints in the credit market, as opposed to farmers that are either deterred from applying for credit or unsuccessful when they manage to apply. Unlike many impact evaluation methods, this approach obtains the measured treatment effect on performance by comparing the treated individuals with a randomly selected individual from the sample. From the regression estimates, one can obtain the predicted outcomes, which would yield the average treatment on credit benefitting farmers or the treated group (*ATT*) and on the credit constrained farmers or the untreated or control group (*ATU*):

$$ATT = E(y_{1i}|c_i = 1, X_{1i}) - E(y_{0i}|c_i = 1, X_{1i}) \quad (3)$$

$$ATU = E(y_{1i}|c_i = 0, X_{0i}) - E(y_{0i}|c_i = 0, X_{0i}) \quad (4)$$

As a first appreciation, the model is regressed by pooling all types of credit constraints, irrespective of whether they manifest during the pre- or post-application stages. Afterwards, these two types of credit constraints are considered separately, allowing not only gauging the relative importance of each explanatory factor at each stage, but also determining the extent to which each series of constraints is holding back farmers' performance.

V. Data and descriptive analysis

The data used in this study are collected in 2013 through a survey in the agro-ecological region of the Senegal River Valley, in the administrative regions of Saint-Louis, Podor, and Matam. The sampling procedure followed a two-stage random process. First, three rural communities have been

picked randomly. Second, in each rural community, households have also been selected randomly, and the number of households in each community follows the size of the latter.

In the end, close to 200 farmers have been surveyed, mostly smallholders (3 out of 4 operated in land which size is less than 2 hectares). Table 1 shows that most credit constraints tend to manifest at the early stage of the credit application (pre-application constraints) by simply deterring farmers from applying in the first place. In effect, close to 3 out of 5 farmers (59 percent) stay out of the credit market, mainly for reason having to do with a burdensome application process (transaction cost constraints), high borrowing cost (price constraints), and a great deal of risk aversion (risk constraints).

Table 1. Credit constraints among farmers.

		Frequency/Average	Type of constraints
NON-APPLICANTS		**0.59**	
Reasons:	Lack of collaterals	0.13	TC
	Complicated process	0.09	TC
	Interest rates too high	0.06	PC
	Inadequate length/amount	0.02	RC
	Not optimistic about outcome	0.04	RC
	Against religious beliefs	0.03	RC
	Other reasons	0.22	
APPLICANTS		**0.41**	
Rejection		**0.03**	
Reasons:	Inadequate collaterals	0.02	QC
	Insufficient returns	0.01	QC
	Too much indebtedness	0.01	RC
	Other reasons	0.01	
Acceptance		**0.38**	
	Amount (million CFA)	1.13	
	Interest rates (%)	7.61	
	Length (months)	7.37	

Notes: Frequencies are calculated over the whole sample across farmers (not crop level). Various types of credit constraints allowed by the data are transaction-cost (TC), price (PC), risks (RC), and quantity (QC), and the categorization follows Ali *et al*. (2014). Because of small size of some categories, we favor a grouping that distinguishes between the pre-application stage (constraints on non-applicants) and the post-application one (constraints on unsuccessful applicants).

Source: Author's calculations, from farm-level survey data.

On the other hand, two out of five farmers, or 41 percent, end up applying for credit. Microfinance institutions are the main source, with 63 percent of applications, against 42 percent for regular banks, and 3 percent for government and non-government institutions. The Table indicates a relatively low rejection rate: 3 percent for the whole sample, or 7.3 percent of applicants, which is far below the rejection rate elsewhere.[9] The constraints materialize because of inadequate collaterals provided by farmers, insufficient returns on the farmer's activity, or an already high level of indebtedness. Because of a lack of sufficiently detailed information, it is not possible to identify unconstrained farmers among non-applicants for "other reasons" that do not need credit because

[9] For business firms in Senegal, Seck *et al*. (forthcoming) indicate a rejection rate of 15.9 percent.

they have sufficient resources, nor is it possible to identity quantity-constrained farmers among successful applicants who would like to obtain larger loan amounts.

Overall, 41 percent of farmers face any known form of credit constraints. Most of these constraints occur at the pre-application stage, thereby constituting market entry barriers. For farmers lucky enough to enter the market (submit an application), the likelihood that their application is successful is rather high (92.7 percent), suggesting very different credit profiles between applicants and non-applicants.

Table 2 offers a comparison between farmers who are credit-constrained and those who are not. As far as performance is concerned, access to credit tends to be associated with higher yields, but lower labor productivity. This could be a suggestion that credit allows farmers to make the most out of the cultivated, thanks to new investments in more efficient production techniques and additional equipment, and the ability to cultivate increased land size and benefit from any return to scale. Additional differences between constrained and unconstrained farmers are the higher propensity of the latter to cultivate more crops per year, to be a member of a farmers' organization, and to own the cultivated land. A more rigorous econometric analysis would tell whether these differences are driven by or a result of credit constraints or other factors.

Table 2. Descriptive statistics across credit market outcomes

	Credit market outcome			Sample
	Access to credit	Credit constrained	Difference	
Yields (FCFAmillion per hectare)	1.4	1.0	0.4***	1.2
Labor productivity (FCFAmillion per worker)	0.5	0.6	-0.1*	0.6
Land size (hectares)	3.5	1.4	2.1***	2.5
Number of cultivated crops (per farmer)	2.7	2.4	0.3*	2.5
Experience in farming (years)	25.3	23.8	1.5*	24.6
Affiliation to farmers' organizations (%)	92.5	64.7	27.8***	84.9
Ownership (farmers own the land, %)	90.2	87.2	2.9*	88.1

Notes: The statistics are obtained at the crop level. The stars denote the conventional significance levels of the t-test comparison between means.

Source: Author's calculations, from farm-level survey data.

VI. Results and discussions

Table 3 shows the estimation results of the baseline model where the dependent variable of the selection equation considers farmers with access to credit and their counterparts who face any type of constraints. The modeling approach (ESR) is validated by the significance of likelihood ratio test of independence between the equations, the Mills' ratio, as well as the instrument in the selection equation. They are indicative of a farmers' self-selection into the credit market as well as the endogenous nature of access to credit. An OLS approach would have generated biased and inconsistent estimates.

The estimates of the correlation coefficients (ρ_j) between the error term in the selection equation and each error term in the performance equation suggest a positive impact of access to credit on farm performance. In effect, the negative sign of ρ_1 tells that access to credit has indeed benefited successful credit applicants. The corresponding gains, as suggested by the *ATT*, are a 0.12-percent increase in labor productivity, and a 1.25-percent increase in yields. These positive results tend to be in line with Akudugu (2016) for Ghana or Ali *et al*. (2014) for Rwanda.

Table 3. Estimation results (combined credit constraints)

	Labor productivity			Yields		
	Access	With credit	No credit	Access	With credit	No credit
Farming experience	0.014***	5.213***	5.989***	0.048***	18.585**	6.859
	(0.01)	(2.14)	(2.80)	(0.01)	(9.10)	(10.28)
Ownership	0.229**	-15.291***	-367.438***	0.182*	-84.294***	-349.351***
	(0.11)	(4.00)	(35.45)	(0.10)	(17.88)	(89.55)
Affiliation	0.756***	242.614***	165.175*	0.781***	-216.782***	195.688***
	(0.23)	(99.29)	(93.01)	(0.21)	(42.54)	(36.60)
Land size	0.027***	-1.507	45.013***	0.006	-37.961***	-12.266
	(0.01)	(3.19)	(13.80)	(0.01)	(13.71)	(41.15)
Rice crop	-0.514	26.831	-303.018***	-0.479	-993.712***	-817.649**
	(0.20)	(62.77)	(107.33)	(0.19)	(265.44)	(381.53)
Direct sales	0.160	171.695***	131.415*	0.199	303.454	-186.064
	(0.15)	(50.28)	(72.77)	(0.14)	(214.91)	(304.20)
Storage	0.442***	-19.871	39.500	0.516***	118.565	1278.210***
	(0.19)	(76.45)	(86.24)	(0.17)	(325.56)	(331.29)
Processing	0.294***	236.409***	288.721***	0.234*	911.621***	-544.877
	(0.12)	(58.50)	(103.08)	(0.13)	(251.12)	(363.89)
Access rate: crop/area	0.046***	---	---	0.057***	---	---
	(0.01)	---	---	(0.00)	---	---
Intercept	-3.525***	680.991***	337.068***	-4.271***	3231.821	915.828
	(0.48)	(149.28)	(153.93)	(0.43)	(629.41)	(574.71)
Number of obs.	213			217		
Wald chi2(8)	19.56**			17.68**		
Log likelihood	-1337.55			-1570.38		
LR test of indep. (Chi2)	5.86**			13.37***		
Mills' ratio (credit)	0.91*			0.73		
Mills' ratio (no credit)	1.47**			1.50*		
ρ_1 (credit)	-0.26*			-0.32*		
ρ_0 (no credit)	0.17*			0.82***		
lny1_1	5.60***			8.09***		
lny0_1	5.49***			6.83***		
ATT	*0.12**			*1.25****		
lny1_0	6.17***			7.81***		
lny0_0	5.61***			6.82***		
ATU	*0.57*			*0.99****		

Notes: Regressions are performed at crop level. Labor productivity and yields are expressed in FCFA 1000s, for the sake of rescaling the coefficient estimates. “Access” refers to the first stage estimation results for the probability of credit access (all types of credit are considered), while the remaining two series of results pertain to labor productivity and yields (FCFA 1000s) for farmers with and without access to credit (second stage). The predicted outcomes at the bottom of the table are in logarithm. The standard errors are between parentheses, and the stars denote to the conventional significance levels.

Our results go even further by indicating that even farmers who are credit-constrained stand to gain from access to credit, as suggested by the positive ρ_0. In effect, if credit constraints at any stage of the application process were to be removed, so as farmers would enter the market and successfully apply for credit, then they would have enjoyed an average a 0.99-percent increase in yields. Labor productivity would also have increased, although not significantly.

In addition to access to credit, various factors also contribute to farmers' performance. Access to credit contributes to shape the extent to which these various factors contribute to productivity or yields. This is indicative that credit has a far reaching implication for farming activities, as it determines the production technology that, in the end, tells about the ability of farmers to transform their environment (captured by the various explanatory variables) into performance-enhancing factors. For instance, when it comes to yields, farmers with access to credit are able to make the most out of their farming experience or the lack of ownership or processing units, in terms of increased performance, than their credit-constrained counterparts. The latter tend to reap greater benefits from their affiliation to farmers' organizations or from storage facilities. As far as labor productivity is concerned, access to credit tends to be associated with a greater impact of farmers' organization as well as being able to sell the harvested crop directly to the market.

The results are also suggestive of a reverse causality, namely, the prospects of higher performance associated with the proceeds of a successful credit application provide incentives for farmers to enter the credit market. Additional determinants of access to credit include all the explanatory variables except direct market sales. More experienced farmers, those with ownership of the cultivated land, as well as affiliated farmers are more likely to access to credit, because from the financial sector perspective, such farmers are more likely to have accumulated greater knowledge and know-how, to provide adequate collateral, and to exhibit a greater social capital, especially when it comes to group lending. Owning a storage facility or a processing unit, either individually or collectively, improve the likelihood to obtain credit, as they tend to be associated with farmers' ability to extract most market values from their crop, by avoiding post-harvest loss or by going further into the value chain. These factors tend to significantly shape the credit profile of farmers, which tends not to be responsive to the crop portfolio or whether farmers sell directly or indirectly to markets.

Table 4 shows the estimation results with a break-down of credit constraints by distinguishing between pre- and post-application constraints in the selection equations. The results first suggest that each type of constraints has a detrimental effect on farmers' performance, and removing them would generate significant gains. The magnitude of the latter varies depending on the indicator of performance as well as the reference group. For instance, when it comes to labor productivity, removing pre-application constraints is associated with a 0.27-percent increase for farmers already benefiting from credit, and would generate a 0.73-percent increase for actually constrained farmers were they to successfully circumvent the credit market entry barriers. The corresponding increase in productivity brought about by removing post-application constraints is respectively 0.39 and 0.59 percent.

The gains measured in terms of an increase in yields tend to be larger. Unconstrained farmers are able to reap 1.21-percent increase in yields as a result of not being deterred by the pre-application constraints, and a 0.81-percent increase that comes about because of their overcoming the post-application constraints.

Table 4. Estimation results (pre- and post-application credit constraints)

	Access to credit vs. pre-application credit constraints						**Access to credit vs. post-application credit constraints**					
	Labor productivity			Yields			Labor productivity			Yields		
	Access	With credit	No credit	Access	With credit	No credit	Access	With credit	No credit	Access	With credit	No credit
Farming experience	0.017***	4.978**	9.691***	0.010*	19.834**	1.023	0.229*	16.424**	25.793**	0.011**	16.654**	26.023**
	(0.01)	(2.13)	(2.79)	(0.01)	(9.08)	(11.56)	(0.13)	(7.56)	(11.78)	(0.01)	(8.39)	(12.61)
Ownership	0.352*	-22.895***	-487.008***	0.233	-47.698**	-154.628***	0.399**	-15.665**	-403.922***	0.434**	86.866***	-259.223***
	(0.21)	(4.02)	(27.11)	(0.22)	(17.65)	(39.17)	(0.19)	(7.71)	(30.70)	(0.20)	(13.96)	(43.60)
Affiliation	0.802***	237.587**	144.738	0.895***	-216.406***	201.733***	0.044***	106.624	98.611	0.041*	98.924***	145.145***
	(0.25)	(98.99)	(96.48)	(0.23)	(42.59)	(41.36)	(0.01)	(80.22)	(108.65)	(0.02)	(34.70)	(44.31)
Land size	0.028**	-1.372	52.583***	0.002	-37.071***	-9.879	-0.524***	-3.618	50.486***	0.005	-39.671***	-47.74
	(0.01)	(3.18)	(12.63)	(0.01)	(13.68)	(45.63)	(0.17)	(3.08)	(13.36)	(0.01)	(13.58)	(53.22)
Rice crop	-0.590**	23.662	-566.633***	-0.440**	-101.590***	-813.613*	-0.111	-7.934	-370.760***	-0.787***	-100.157***	-193.745***
	(0.22)	(62.53)	(110.25)	(0.22)	(26.49)	(436.45)	(0.13)	(55.97)	(100.25)	(0.21)	(25.06)	(45.29)
Direct sales	0.094	-127.298**	-86.861	0.218	315.705	-167.216	0.721***	-122.946**	-157.755	0.304**	271.334	-201.459
	(0.17)	(50.05)	(85.40)	(0.16)	(214.63)	(359.15)	(0.16)	(45.87)	(90.45)	(0.14)	(202.49)	(391.64)
Storage	0.414*	-15.579	-37.365	0.627***	122.347	1340.712***	-0.109	44.401	-52.941	0.730***	159.828	1545.427***
	(0.22)	(76.18)	(85.43)	(0.19)	(325.94)	(365.01)	(0.15)	(71.92)	(110.83)	(0.17)	(304.94)	(430.99)
Processing	0.190*	235.949***	535.589***	0.331*	911.691***	-619.673	0.254	158.443***	435.160***	-0.092	690.050***	-292.307
	(0.11)	(58.46)	(106.39)	(0.18)	(250.96)	(435.01)	(0.19)	(54.74)	(104.65)	(0.16)	(241.90)	(441.70)
Access rate: crop/area	0.048***	---	---	0.057***	---	---	0.034***	---	---	0.030***	---	---
	(0.01)	---	---	(0.01)	---	---	(0.01)	---	---	(0.01)	---	---
Intercept	-3.535***	665.784***	365.715**	-4.338***	3192.502***	823.112	-1.589	407.976***	541.516***	-1.690***	2133.895***	709.192
	(0.52)	(147.75)	(145.64)	(0.47)	(629.57)	(627.71)	(0.29)	(134.66)	(145.11)	(0.32)	(558.83)	(650.13)
N	168			173			109			117		
Wald chi2(8)	19.42**			17.71**			25.29***			15.86**		
Log likelihood	-1270.53			-1502.02			-1403.75			-1577.15		
LR test of indep. (Chi2)	6.29**			10.53***			6.13**			8.96***		

Mills' ratio (credit)	0.57	0.98*	0.37	0.68
Mills' ratio (no credit)	1.60**	1.61*	1.56**	1.62**
ρ_1 (credit)	-0.25**	-0.31*	-0.11	-0.31*
ρ_0 (no credit)	0.31*	0.76***	0.34**	0.40*
lny1_1	5.59***	8.07***	5.67***	7.71***
lny0_1	5.32***	6.86***	5.29***	6.91***
ATT	***0.27****	***1.21*****	***0.39*****	***0.81*****
lny1_0	6.11***	7.80***	6.10***	7.75***
lny0_0	5.38***	7.01***	5.51***	6.64***
ATU	***0.73*****	***0.80*****	***0.59*****	***1.10*****

Notes: Regressions are performed at crop level. Labor productivity and yields are in FCFA 1000s. “Access” refers to the first stage estimation results for the probability of credit access, while the remaining two series of results pertain to labor productivity and yields for farmers with and without access to credit (second stage). The predicted outcomes at the bottom of the table are in logarithm. The standard errors are between parentheses, and the stars denote to the conventional significance levels.

For actual non-applicants or unsuccessful applicants, removing the pre-application constraints would generate a 0.8-percent increase in yields, while relaxing the post-application constraints would bring a 1.1-percent increase in yields.

Overall, credit constraints are holding back farmers' performance, both in terms of labor productivity and in terms of yields. Removing credit constraints and promoting financial inclusion through access to credit would generate significant, and yet heterogeneous returns. In effect, the extent to which the credit constraints are harming performance tends to depend on the stage at which they materialize, as the incidence of barriers that prevent farmers from entering the credit markets (pre-application constraints) tend to be significantly larger or smaller than that of the constraints responsible for the failure of the credit application (post-application constraints). The relative magnitude appears to be dependent upon a specific group of farmers one focuses on (actual credit beneficiaries or actual credit-constrained farmers), as well as the performance indicator that favors the efficiency with which land or labor is used in the production process.

As far as policy is concerned, one should consider this dual approach to financial inclusion in the form of access to credit by distinguishing between the pre- and post-application stages of the credit application process. As the results suggest, they tend to be different in terms of their incidence and implication as far as the performance of farming and the livelihoods of farmers are concerned. Focusing on the pre-application phase would amount to removing barriers to credit market entry. For instance, familiarizing farmers, with limited education and literacy, with the application process, as well as simplifying the latter, would be a good step towards reducing transaction cost constraints. The development of adequate financial instruments that would match the financial needs of farmers in terms of the length of the crop cycle and the expenses on various inputs on one hand, and the religious beliefs of farmers who are mostly Muslims, through a greater implication of the Islamic Bank of Senegal for instance, would contribute to lessen the risk constraints.

Additional policy options should contribute to increase the likelihood that applicants become successful. It can be expected that the ongoing land reform that seeks to provide property rights to farmers would help with the collateral requirements. A greater technical support from the government through the SAED would contribute to improve the performance of farming activities, which in turn increase their financial attractiveness and thereby bring additional financial suppliers to the credit market.

VII. Conclusion

The unrivaled potentials of the agricultural sector to improve the socio-economic conditions of large proportions of the populations have not been matched by the level of financial inclusion in the form of access to credit. By deterring some farmers (non-applicants) from entering the credit market on one hand, and by rejecting various credit applications, the credit market is holding back farming performance. This paper has shown that, in effect, in the specific agro-ecological region that has long been the focus of government support and various extension services, credit constraints have a negative effect on labor productivity and yields. No access to credit often translates into farmers' inability to modernize the production process and to reach greater technology, which in turn makes them less financially attractive. This is an indication of some form of vicious circle of low farming performance and financial exclusion.

Consequently, improving financial inclusion and rationalizing farming processes are two key policy directions to be considered, either individually or combined, as they appear to reinforce each other. As far as improving access to credit is concerned, the results suggest to first distinguish between the initial, pre-application stage of removing the barriers to credit market entry (mostly in the form of transaction cost constraints and risk constraints), and the post-application stage that consists of tackling mostly quantity constraints associated with inadequate collaterals or insufficient returns. It is expected that easing these constraints would promote financial inclusion, and help tap into the great potential of farming activities through increased performance and improved livelihoods for a large share of the population, especially in rural areas.

The extent to which the results and the resulting implications could pertain to the agricultural sector as a whole may not however go very far. The two main reasons have to do with (i) the uniqueness of agro-ecological region of the Senegal River Valley, and (ii) data limitations, mostly the relatively small sample size (which has commanded to work at the plot/crop level) may in fact. A larger sample, in conjunction with a better coverage of the diverse agricultural landscape of the whole country, would certainly have provided a better portray of the complexity of the interaction between the farming sector and the credit market as far as financial inclusion is concerned.

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Annexes

Table A1. Variable definition and specification

Variables	Specification
Dependent variables: outcome equation	
Labor productivity	Output per worker (FCFA 1000s)
Yields	Output per hectare (FCFA 1000s)
Dependent variables: selection equation	
Access to credit vs. all constraints	Dummy: 1 if no constraint, 0 if any type of constraints
Access vs. trans. cost and risk constraints	Dummy: 1 if no constraint, 0 if TC and risk constraints
Access vs. price and quantity constraints	Dummy: 1 if no constraint, 0 if price and quantity constraints
Independent (control) variables	
Farming experience	Years in farming activity
Ownership	Dummy: 1 if farmer owns the land, 0 otherwise
Affiliation (to farmers' organization)	Dummy: 1 if affiliated to an organization, 0 otherwise
Land size	Size of cultivated land (ha) for the corresponding crop
Rice crop	Dummy for rice: 1 if yes, 0 otherwise
Direct sales	Dummy, whether sold directly to markets: 1 if yes, 0 otherwise
Storage facilities	Dummy if have access to storage facilities: 1 if yes, 0 otherwise
Processing units	Dummy if have access to processing units: 1 if yes, 0 otherwise
Credit access rate: area and crop	% of farmers with access to credit within the same village and cultivating a similar crop