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Female Entrepreneurship, Access to Credit, And Firms' Performance in Senegal

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Abstract

Despite an increase in the share of female-owned existing and new start-up firms in Senegal, there is still a wide belief that female entrepreneurs are discriminated against in the credit market. This paper empirically investigates such gender-based discrimination, and the extent to which it might be translated into lower efficiency. Using firm-level data and a methodological approach that consists of the data envelopment analysis, an endogenous switching regression and a propensity score matching, the paper finds no evidence to support the common wisdom that women are discriminated in the credit market. In addition, to the extent that they benefit from credit, female reap equal returns from the funds, efficiency-wise. These results do not however call for the abandonment of gender-biased public policies aiming at promoting access to credit and entrepreneurship, but suggest they be grounded on more robust footings such as managers' education, firms' ownership, sectorial activities with respect to capital intensity, and geographical locations.

JEL: G21; J16; L25.
Keywords: Gender, access to credit, firms' efficiency, Senegal.

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1 Introduction

Empowering women by promoting female entrepreneurship tends to be associated with both economic and social gains. Because they make up more than half of the population, encouraging women in the business sector has a potential to enlarge the productive capacity of a nation by just adding into both the active population and the number of business firms. This would tap into their seemingly higher propensity to start a business. In effect, a report by Global Partnership for Financial Inclusion (GPFI, 2011) shows that women in developed countries are starting businesses at a higher rate than men, for instance to the tune of 23 percent against 9 percent in the USA. In addition, a relatively large share of business firms are owned by female, as it is the case in Canada where some 47 percent of small enterprises are female-owned and about 70 percent of new start-ups are also female-owned.

One can reasonably argue that such high business orientation is also a characteristic of females in the developing world, which would materialize only to the extent that the many constraints to female entrepreneurship would allow it. In Senegal for instance, the World Bank's *Enterprises Survey* data in 2007 revealed that close to a quarter (23.8 percent) of small and medium businesses are owned by females. The same survey indicated a similar figure in 2003 (23.6 percent), but more recent data[1] showed a significant increase to 32.3 percent.[2] At the same time, female entrepreneurs accounted for 38.1 percent of new start-up businesses in 2010, against 25 percent in 2000.

Moreover, a clear distinctive feature between business firms owned by male and female is their seemingly greater potentials for job creation. The recent data in Senegal indicate that on average, female-owned businesses employ 16.2 percent more workers than their male-owned counterparts. In addition, the employment profile in female-owned business firms tends to favor the segment of the population that have lower chances to succeed in the labor markets, namely women (15.8 percent more). This shows the higher impact of female entrepreneurship on unemployment reduction and poverty alleviation in the country.

It is somehow paradoxical that this relatively wide recognition of these economic and social benefits associated with female entrepreneurship might be coupled with many forms of discrimination, chief among them being in access to credit. There is a large body of theoretical work that provides a clear understanding on how market imperfections can generate credit rationing that may translate into some forms of discrimination against some loans' applicants (see for instance Stiglitz and Weiss, 1981; Binswanger and Rosenzweig, 1986; Gorman et al., 2005). The empirical literature however appears to be less settled and suggests mixed results both in terms of the extent and direction of credit rationing along the gender line, if any, and in terms of its generating mechanisms. In the context of Sub-Saharan Africa, for instance, some studies indicate some discrimination against women (Assiedu et al., 2013), others point to the opposite (Hansen and Rand, 2011, whilst others suggest no gender-based discrimination (Bardasi et al., 2011).

To the extent that such differential in access to credit does exist, empirical evidence also suggests mixed results in terms of how they translate into firms' performance. For instance, Sabarwal and Terrell (2008) document a performance gap between female- and male-managed firms: the latter tend to be larger (sales-wise) and more efficient (total factor productivity) than the former. The authors indicate that the sub-optimal

[1] The authors gratefully acknowledge a support from TrustAfrica for the data collection in 2013.

[2] The Sub-Saharan average is 35.0 percent (Source: World Bank's *Entreprises Survey*, http://www.enterprisesurveys.org/data/exploreTopics/Gender, accessed on December 11, 2014).

size of female-owned firms have to do with capital constraints. Bardasi et al. (2011) also document significant size differential between female- and male-owned companies (the latter tend to be bigger than the former), but, as far as efficiency is concerned, the authors suggest that one dollar received by male-owned firms generates equal returns in terms of sales or revenue than the one received by female-owned firms. Nwaru and Onuoha (2010) suggest similar results for Nigeria, and Khan et al. (2013) for Pakistan.

These various results tell little about how the credit market in a specific country tends to operate. As far as the Senegalese case is concerned, there is, to our knowledge, no formal study looking into how the specific economic, social, cultural, and institutional mechanisms interact to generate the many specific constraints to female entrepreneurship in the credit market, if any, and how they translate into firms' performance. As a consequence, there is a lack of empirical foundations for government policies which have gone as far as to set up a Ministry in charge of female entrepreneurship, as well as a National Fund for the Promotion of Female Entrepreneurship. The latter provides credit to female entrepreneurs at below-the-market interest rates and other favorable conditions. Whether such strategies are well grounded still remain to be tested.

In the face of an empirical literature that produces mixed results as far gender discrimination in the credit market is concerned and its implications for firms' performance, only country-specific studies could reveal how the phenomenon plays out in the country in question. Such a study should provide answers to the following questions: (i) To what extent are female entrepreneurs constrained in credit markets in Senegal compared to male, if any? (ii) What are the specific factors (other than preferences over the types of firms, social and cultural characteristics) that generate such disparities in the credit market? (iii) To what extent is any gender-based differential in the credit market translated into differences in firms' performance? Are the answers to these questions varied across business activities and across the different regions of the country?

This study sets out to provide answers to these questions. More specifically, its main objectives are to analyze the extent to which female entrepreneurs are discriminated against credit market, if any, and how such a disparity in access to credit is translated into any performance differential. The paper adds to the existing vast literature that more often tends to develop in three separate directions: gender and firms' performance, gender and access to credit, and access to credit and firms' performance. The paper combines all three issues within an empirical framework with the recognition that any one outcome is more likely to be both an explanation and a result of the others.

The empirical methodology builds around these three nexuses and consists of two parts, with the usual assumption of orthogonality between the choice of productive inputs and firms' general characteristics. The first part develops a non-parametric approach to measuring performance, namely efficiency. More specifically, the data envelopment analysis approach is considered to compute technical efficiency (more precisely cost efficiency, since value data on capital and labor inputs and on output are used in the production function), namely firms' ability to maximize its output for a given level of inputs. The second part of the methodology relates efficiency scores to a set of correlates using an endogenous switching regression model. Such a model allows dealing with very likely issues of endogeneity and self-selectivity biases. The great deal of heterogeneity across firms with respect to various factors (sectors, size, etc.) is accounted for through the inclusion of dummy variables in the regression analyses. Data limitations (i.e. small sub-sample size) do not allow computing efficiency scores within separate sectors, and pooling the data has the advantage to additionally capture structural, sector-specific inefficiencies. Because efficiency can be viewed as the outcome of an assignment process (access to credit), the success of any policy aiming at loosening credit constraints will be measured on both beneficiaries (treated) and non-beneficiaries (untreated or controls) of credit, using both the switching regression model and the propensity score matching technique.

2 Literature review

There is a large body of theoretical work that provides a clear understanding on how market imperfections can generate credit rationing that may translate into some forms of discrimination against some loans' applicants (see for instance Stiglitz and Weiss, 1981; Binswanger and Rosenzweig, 1986; Gorman et al., 2005). For example, Stiglitz and Weiss's theoretical insights suggest that credit rationing arises from information asymmetry between borrowers and lenders, which makes the latter more prone to not always select good borrowers (adverse selection), and face a risk associated with their behavior that may not always be in line with their best interest (moral hazard).
As a consequence, price mechanisms will not always guarantee equilibrium in the sense that some borrowers not willing to pay the relatively high interest rate will be constrained. Moreover, in the face of lack of full information about the borrowers' projects, lenders may resort to non-market mechanisms to discriminate against some of them (Gorman et al., 2005).
As far as gender is concerned, Becker (1971) argues that the (formal) credit market can discriminate against female entrepreneurs in various and often overlapping ways: lenders can charge higher interest rates on loans offered to women entrepreneurs than their male counterparts; or it can require stronger contractual arrangements when considering to grant loans to women; or it may require better credit profile to female entrepreneurs seeking loans.
The empirical literature however suggests mixed results both in terms of the extent and direction of credit rationing along the gender line, if any, and in terms of its generating mechanisms. For instance, Bardasi et al. (2011) find no significant difference in credit access between male and female entrepreneurs by examining the widely used World Bank's *Enterprises Survey* data for Sub-Saharan Africa, Latin America, and Eastern Europe and central Asia.
Other studies did however document some discrimination in the credit market, and it is not always against female entrepreneurs. Kondo (2003) suggests that lenders in Philippines are more willing to lend to women entrepreneurs than to their male counterparts, for reasons having to do with the higher willingness of the former to preserve a stronger social capital, some elements of which being social ties and reputation. This ease of access to credit could, however, in some cases, lead to more borrowing and greater difficulties to repay the loans, resulting in lower credit worthiness and ultimately to credit rationing. In effect, Malpit (2010) suggests that when lenders screen borrowers with respect to their credit profile, women appear to be more credit constrained than men. Other mechanisms, especially non-market ones, that seem to underlie discrimination against women have to do with firm size (Hansen and rand, 2012), age, marital status, family size, capital assets, interest rates, education, experience, or attitudes towards risk (see for instance Messah and Wangai, 2011; Ajagbe, 2012; Garba, 2011).
Overcoming the many hurdles in the credit market could be one way to improve firms' performance, especially for firms that face greater credit-constraint. In effect, access to credit spells a possibility to expand the production possibilities through greater capital accumulation, be it physical or technological. Firms 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 greater access to finance can contribute to lower the average cost, especially in the context of increasing returns to scale. This is synonymous to firms' ability to minimize their input usage to reach a given level of output. To the extent that a firm might be constrained in the credit market, all of these efficiency gains could be unreachable.

There is some empirical literature that relates firms' efficiency level and access to credit, thereby trying to translate any gender-based discrimination into performance differential. For instance, Sabarwal and Terrell (2008) document a performance gap between female- and male-managed firms: the latter tend to be larger (revenue-wise) and more efficient (total factor productivity) than the former. The authors indicate that the sub-optimal size of female-owned firms has mainly to do with capital constraints. Bardasi et al. (2011) suggest that when it comes to firm size, male-owned firms tend to be bigger than their female-owned counterparts, but as far as efficiency is concerned, very small gap in favor of male-owned firms is found. The authors indicate that one dollar received by male entrepreneurs is not translated into higher returns in terms of sales or revenue than the one received by female entrepreneurs.

Furthermore Nwaru and Onuoha (2010) suggest in the case of farming activities in Nigeria that credit does not contribute to increase 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. 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 reasons have to do with "high interest rate, delay in credit disbursement, and lengthy procedure of getting credit" (p. 1).

Overall, the theory seems relatively clear about how information asymmetry could generate credit rationing that could be based on non-market mechanisms, such as gender, and how in turn, credit rationing can adversely affect firms' efficiency. However, on the empirical side, the literature appears to be less settled when it comes to the extent of gender-based discrimination, and how it translates into any efficiency gap. In the end, an empirical study that focuses on the specific nature of the functioning of the credit market, both on the demand (firms) and supply (lenders) sides, would be capable of providing any accurate picture. This is particularly true in countries, like Senegal, where the various public policies have sought to deal with a hypothetical gender-based discrimination in the credit market, but which has not been a true isolated focus of any formal study, to our knowledge.

3 Methodology and data

The methodology is made up of two parts. First, firm efficiency scores are obtained using a non-parametric method. Second, these efficiency scores are related to a host of explanatory factors in a parametric model, namely an endogenous switching regression. This two-part approach relies crucially on the assumption that the choice of inputs and production technology is orthogonal to firms' general characteristics. By introducing gender and access to credit in this parametric model, one would be able to tell whether females are less likely to obtain credit (first-stage regression equation of credit access), and how any gender-related efficiency gap is a result of this credit market outcome (second-stage efficiency models). These empirical methods will be applied using firms' survey data.

3.1 Computing efficiency scores

The Data Envelopment Analysis (DEA) is used to obtain efficiency scores of firms or decision making units (DMU). Broadly understood, efficiency can be viewed as productivity differences across optimizing agents, while productivity is simply a ratio of outputs to inputs. Efficiency therefore tells about the quality of the technology used by a given unit relative to that of the most advanced comparator units. More specifically, based on Charnes et al.'s (1978) approach, it is "the maximum of a ratio of weighted outputs to weighted inputs, subject to the condition that the similar ratios for every DMU be less than unity" (p. 430). For a given DMU k, with $k = 1, \ldots, n$, let s denotes the number of goods being produced, m the number of inputs being used, and let the ratio, referred to as technical efficiency, be as follows:

$$TE_k = \frac{\sum_{r=1}^{s} u_r y_{rk}}{\sum_{i=1}^{m} v_i x_{ik}} \qquad (01)$$

y_{rk} represents the quantity of output $r \, (r = 1, \ldots, s)$ produced by DMU k, x_{ik} the quantity of input $i \, (i = 1, \ldots, m)$ used, u_r and v_i the output and input weights. Higher efficiency can be obtained either through an increase in outputs for a given level of input, or a decrease in input use for a give level of output. The first approach is referred to as output-oriented technical efficiency. An alternative approach produces input-oriented technical efficiency, which corresponds to a minimization of input use to achieve a given level of output. If one assumes a constant-returns-to-scale technology, then both orientations produce similar measures of efficiency. In the case of variable returns to scale, the efficiency frontier will be different from one orientation to the other, but as noted by Coelli and Perelman (1996, 1999), the measures are not significantly affected, most notably when it comes to the ranking of firms.

Using data on inputs and outputs, one can map each DMU in a graph. More efficient firms, that is, firms with the highest ratios, constitute the efficiency frontier (the envelope). They are assigned a score of unity, and represent the benchmarks. The rest of the DMUs that lie under the frontier are assigned scores less than unity, reflecting how far they are from the efficiency frontier, and consequently, by how much their outputs need to rise for a given level of inputs so as to converge to their peers on the frontier. In this sense, the scores reflect a relative measure to efficiency, not an absolute one.

When computing efficiency scores, the main issue is how to obtain the output and input weights (u_r and v_i) for each DMU. A key feature of the DEA approach is that weights are not assigned arbitrarily or uniformly across DMUs. Instead, a different set of weights are calculated for each DMU through a linear programming procedure. Under the assumption of variable returns to scale (Banker et al., 1984), the output-oriented efficiency score for a given DMU k is obtained by solving the following system of equations:

$$Max\ \theta_k = \sum_{r=1}^{s} u_r y_{rk} + c_k \qquad (02)$$

subject to:
$$\sum_{i=1}^{m} v_i x_{ij} - \sum_{r=1}^{s} u_r y_{rj} - c_j \geq 0,\ j \in \{1, \ldots, n\}$$
$$\sum_{i=1}^{m} v_i x_{ik} = 1$$
$$u_r, v_i > 0\ for\ r \in \{1, \ldots, s\}, i \in \{1, \ldots, m\}$$

c_k is a measure of returns to scale for DMU k. The first two constraints guarantee that the scores θ_k are bounded to unity. The last constraints suggest that any given used input or produced output are assigned a (strictly) positive weight, and the magnitude varies positively with its relative importance in the production process.

A typical efficiency assessment exercise often requires both output and inputs to be measured in physical terms, in which case technical efficiency scores are obtained. This has its advantage in a homogenous setting. For instance, employees with the same skills and marginal contribution may receive different wages depending on the level of market distortions in their respective sectors. Taking into account the wages would lead to artificially inflate efficiency scores in sectors with higher wages. But one main drawback of using physical measure of inputs and outputs stems in the case of heterogeneity of products and inputs across sectors. Using quantities would not reveal in any meaningful way the relative efficiency of firms, more so when their inputs are different (say, skills and ability of the labor input). In such a case, a monetary value would be more relevant.

The dataset we use in this paper does not contain information on input or output prices. Instead, labor and capital inputs and total sales that enter the production function come in monetary terms. Using value data in efficiency assessment amounts to considering costs as surrogates for quantities. The resulting measures that are generated are therefore close to cost-efficiency. As shown by Portela (2014), "when prices are unknown and differ across DMUs, cost (revenue) efficiency can be computed using value cost (revenue) data" (p. 7).

Two additional issues also arise when generating efficiency scores. First, there is the possibility that some "super-efficient" firms may act as outliers, thereby seriously distorting the distribution of the scores. In such an instance, the mean score tends to be very low, and the distribution very left-skewed. A sensitivity analysis would reveal the relative importance of such observations, and various techniques have been suggested (see Zhu, 2001, for more details). The rather straightforward, simple graphical examination of, say, sales against total value of inputs would reveal potential outliers. These extreme observations can simply be dropped from the model to improve the distribution of the efficiency scores.

A second issue is concerned with the nature of returns to scale. A constant-returns-to-scale efficiency frontier suggests that the output increases in the same proportion as the inputs, or the ratio of productivity is independent of the scale. It is worth noting that by considering constant returns to scale, the results become highly sensitive to the outliers. Charnes et al. (1978) first developed a DEA model that assumed constant returns to scale. The appropriateness of such an assumption rests on the condition that all DMUs are operating at optimal scale.

An alternative specification assumes variable returns to scale, and is developed by Banker et al. (1984). DEA models based on such an assumption generates efficiency measures that are not confounded by scale efficiencies (Coelli et al., 2005). These various assumptions regarding the nature of returns to scale have led to different measures and interpretations of efficiency (Huguenin, 2013). Under the constant returns to scale assumption, the generated scores provide a measure of "total" efficiency. The assumption of variable returns to scale leads to a measure of "pure" efficiency. This latter is one component of the former, and the ratio between these two yields the second component also referred to as "scale" efficiency. This decomposition suggests the two main sources of (total) inefficiency: poor management or organization (pure inefficiency), and inappropriate scale (scale inefficiency). All of these three measures will be considered, with a particular focus on total efficiency in the regression analyses.

3.2 The determinants of firms' efficiency

To answer the question of whether there is gender-based differential when it comes to access to credit and how they are translated into firms' efficiency, an endogenous switching regression (ESR) model appears to be well appropriate. This modeling approach deals with a combination of individual heterogeneity, say, in credit worthiness, and self-selection into the group of credit beneficiaries (Maddala and Nelson, 1975). In effect, it is assumed that the propensity to apply for and access to credit is endogenous to firms' efficiency, and some unobserved characteristics may well affect both the probability to access to credit and efficiency. In addition, the prospects of gaining from credit in terms of increased capacity and efficiency could well be a driver to firms' propensity to access credit.
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 equations and the access to credit equation. Suppose the following binary switching equation that sorts individual firms over two different states or regimes: those that have access to credit (regime 1), and those that do not (regime 0):

$$I_k = 1 \;\; if \;\; I_k^* = Z_k\gamma + \mu_k > 0 \qquad (03)$$

$$I_k = 0 \;\; if \; I_k^* = \; Z_k\gamma + \mu_k \leq 0 \qquad (04)$$

$I_k = 1$ indicates that firm k's profile makes it eligible to access credit, while $I_k = 0$ corresponds to a regime in which the firm does not have access to credit. It is considered a latent process I_k^* that governs the observation of regimes, and that depends on a set of variables Z_k and an error term μ_k. Among the components of Z_k is gender, and its coefficient estimate will answer our first research question, that is, whether there is any gender-based difference in the probability of accessing credit. Other firms' characteristics will also be included, such as size (employment), age, ownerships.
The second part of the model consists of the efficiency equations for the regimes. They are specified as follows:

$$y_{1k} = X_k\beta_1 + \varepsilon_{1k} \;\; if \;\; I_k = 1 \qquad (05)$$

$$y_{0k} = X_k\beta_0 + \varepsilon_{0k} \;\; if \;\; I_k = 0 \qquad (06)$$

y_{1k} and y_{0k} are respectively firm k's efficiency score in either regime 1 or regime 0 (θ_k in the DEA linear program), X_k a set of explanatory variables, and ε_{1k} and ε_{2k} two errors terms. The error terms μ_k, ε_{1k} and ε_{0k} are assumed to be normally distributed with a zero-mean and a variance-covariance matrix defined as follows:

$$\Omega = \begin{bmatrix} \sigma_u^2 & \sigma_{1u} & \sigma_{0u} \\ \sigma_{1u} & \sigma_1^2 & . \\ \sigma_{0u} & . & \sigma_0^2 \end{bmatrix} \qquad (07)$$

σ_u^2, σ_1^2, and σ_0^2 are respectively the variances of the error terms μ_k in the discrete equation and ε_{1k} and ε_{0k} in the continuous 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 firm's efficiency score 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). Given these various assumptions, it comes the following log likelihood function:

$$lnL = \sum_k (I_k w_k [ln\{F(\eta_{1k})\} + ln\{f(\varepsilon_{1k}/\sigma_1)/\sigma_1\}] + (1 - I_k) w_k [ln\{1 - F(\eta_{0k})\} + ln\{f(\varepsilon_{0k}/\sigma_0)/\sigma_0\}]) \qquad (08)$$

F is a cumulative normal distribution function, f a normal density function, w_k an (optional) weight for observation k. The statistic η_{jk}, with $j \in \{1,0\}$ is defined as follows:

$$\eta_{jk} = \frac{(\gamma Z_k + \rho_j \varepsilon_{jk}/\sigma_j)}{\sqrt{1-\rho_j^2}} \qquad (09)$$

with $\rho_j = \sigma_{ju}^2/\sigma_j\sigma_u$ the correlation coefficient between μ_k and ε_{jk}.

The correlation coefficient estimates will tell whether a given firm has greater or lower efficiency than the random firm from the sample, as a result of being in the corresponding regime (having access to credit or not). Table 1 summarises the link between the sign of the coefficients of correlation and the contribution of unobservable factors to the impact of the program (access to credit in our case):

Table 1: Correlation coefficients and treatment effects

$\rho_1 < 0$	$ATT > 0$
$\rho_1 > 0$	$ATT < 0$
$\rho_0 < 0$	$ATU < 0$
$\rho_0 > 0$	$ATU > 0$

Notes: ATT stands for Average Treatment on the Treated, and ATU Average Treatment on the Untreated.

Assume a case of positive selection bias for the group 1. In other words, we assume that the probability of being selected and the outcome within the group 1 are positively correlated. In such case, in order to make the group 1 be inferred to the whole population, we need to negatively correct the outcome of this group. This will be translated by a negative sign of ρ_1. Now, assume that we have a negative selection bias of group 0, and the probability of being selected and the outcome within group 0 are negatively correlated. In such case, the correction of the selection bias requires some increase in the predicted outcome of group 0. This form of correction is translated through the positive coefficient of ρ_0.

The results of ESR can also be used to generate conditional expectations which will provide a concise measure of any efficiency differences among firms based on the credit market outcome. The following expressions are considered:

$$E(y_{1k}|I_k = 1, X_k) = X_{1k}\beta_1 + \rho_1\sigma_1 f(\gamma Z_k)/F(\gamma Z_k) \quad (10)$$

$$E(y_{1k}|I_k = 0, X_k) = X_{0k}\beta_1 - \rho_1\sigma_1 f(\gamma Z_k)/\{1 - F(\gamma Z_k)\} \quad (11)$$

$$E(y_{0k}|I_k = 1, X_k) = X_{1k}\beta_0 + \rho_0\sigma_0 f(\gamma Z_k)/F(\gamma Z_k) \quad (12)$$

$$E(y_{0k}|I_k = 0, X_k) = X_{0k}\beta_0 - \rho_0\sigma_0 f(\gamma Z_k)/\{1 - F(\gamma Z_k)\} \quad (13)$$

Expression (10) is the expected efficiency of firms with access to credit, while (12) is the expected efficiency did they not have access to credit. The difference provides a measure of the impact of access to credit for credit beneficiaries. If access to credit is viewed as a program intervention, then the difference refers to the average treatment on the treated (ATT) (see for instance Heckman et al. (2001) and Di Falco et al. (2011)). Expressions (13) and (11) provide similar measures of average efficiencies for credit-constrained firms, and the difference provides a measure of the potential gain of access to credit for non-beneficiaries, referred to as the average treatment on the untreated (ATU).
These treatment effects are obtained from the regression results of the switching model that compares each individual firm with a random individual firm from the sample. An alternative approach known as propensity score matching provides a comparison with individual firm (or group of firms) with similar characteristics, except for the credit market outcome. Each treated firm is matched and compared with counterfactuals that are closest on the basis of observed characteristics, and identified through techniques such as nearest neighbor matching, caliper matching, or kernel matching.
In this paper, we propose to perform a decomposition of the treatment effect into a returns effect and a selection effect, as proposed by Heckman et al. (2001), and this in order to appreciate the contribution of observable factors (returns effect) and unobservable factors (selection effect). The latter will help capture the fact that, regardless of the credit, some credit beneficiaries may have been more efficient than non-beneficiaries, because of some unobservable factors. This decomposition will help of giving more interpretation of results and to show the extent of selection bias correction. For this end, we start by summarising the treatment effects and the new components in Table 2.

Table 2: Average treatment effect and selection bias correction

	Average treatment effect	***Returns Effect (RE)***	***Selection Effect (SE)***
Treated group	$E(y_{1k}\|I_k = 1, X_{1k}) - E(y_{0k}\|I_k = 1, X_{1k})$	$X_{1k}(\beta_1 - \beta_0)$	$(\rho_1\sigma_1 - \rho_0\sigma_0)\lambda_{1k}$
Untreated group	$E(y_{1k}\|I_k = 0, X_{0k}) - E(y_{0k}\|I_k = 0, X_{0k})$	$X_{0k}(\beta_1 - \beta_0)$	$(\rho_1\sigma_1 - \rho_0\sigma_0)\lambda_{0k}$

where $\lambda_{1k} = f(\gamma Z_k)/F(\gamma Z_k)$ and $\lambda_{0k} = f(\gamma Z_k)/[1 - F(\gamma Z_k)]$.

While the propensity score methods generate the counterfactual mainly through observable factors, the regression-based comparison assumes that both observable and unobservable characteristics matter when it comes to access to credit and efficiency. To the extent that observable factors come to play a greater role than the unobservable ones, then the generated measures may not be qualitatively different.

3.3 The data

We use firm-level data collected in 2013 as part of a research project that was concerned with firms' productivity and electric power outages in Senegal.[3] A sample of 606 firms was surveyed in four main regions: Dakar, Thies, Saint-Louis, and Kaolack. They happened to be the most economically advanced regions in Senegal. Because they concentrate a large proportion of businesses, they offer clear indications of the many constraints that firms face in their regular activities.

The survey has collected detailed information on various aspects of firms' activities. Initial questions relate to firms' characteristics, one of them being the gender of the owner. Then, there is a whole set of questions that detail firms' activity and use of inputs: sectorial distribution, value of output and inputs, investment, etc. Another set of information is concerned with finance. Questions relate to whether firms have applied for credit, the type of lenders (banks, microfinance institutions), whether their demand has been met (which defines access to credit, and which tells about firms' credit worthiness), the conditions of the loans (collaterals, amount, interest rates, duration, etc.), and the reasons for rejection or no application for those that were denied or have not applied.

Table 3 offers some summary statistics related to gender and access to credit, and Table 8 in the appendix shows more detailed descriptive statistics of the data. The distribution of firms across gender shows that about a third of them are female-owned.[4] When it comes to credit, female entrepreneurs appear to be more likely to apply than their male counterparts. When they do not apply, they invoke reasons mostly related to the cost of borrowing (high interest rates), more so than male entrepreneurs who also complain about the application procedure.

Female's larger propensity to apply for credit tends to counterbalance the relatively lower success rate in their credit application, which is mostly due to inadequate collaterals and incomplete application. As a result, female entrepreneurs have a greater chance to access to credit than their male counterparts: 17.5 against 15.0 percent.

One caveat with the data is the lack of information on firms that self-select out of the credit market for any given reason. The access to credit ratio should normally rule out such firms, and include only firms that actually did apply to credit, successfully or otherwise, and firms who would have applied had the interest rates not been too high, or the application procedures less burdensome, or collateral requirements more affordable. For the rest of non-applications, the unspecified reasons do not allow identifying firms that did not need credit *per se* and are voluntarily out of the credit market altogether. We therefore hypothesize that to the extent that such firms do exist, their number may be marginal enough to include them in the access to credit ratio and the subsequent empirical analysis.

Firms' credit profile tends to be different across gender: the smaller credit amount and shorter duration for female are associated with higher interest rates on their credits. Overall, credit seems to contribute relatively little in firms' financing needs: a meager 4.5 percent. As a consequence, self-financing represents by far the single most important financing source, with on average of almost 80 percent, and more so for male than female entrepreneurs. How the functioning of the credit market interacts with gender and other firms' characteristics to generate firms' efficiency is formally explored in the next section.

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[3] Support from Trust Africa is gratefully acknowledged.

[4] The paper focuses on the gender of the owners. It could have been equally insightful to focus on the managers, but such information is not available in the dataset.

Table 3: Summary statistics of the data

	Female-owned		Male-owned		Total sample	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
Distribution (%)	34.8	0.48	65.2	0.48	100.0	---
Credit application in 2011 (%yes)	20.0	0.40	18.1	0.39	18.7	0.39
Reasons for non-application						
High interest rates	29.9	0.46	16.6	0.37	21.2	0.41
Procedure	14.1	0.35	16.0	0.37	15.3	0.36
Collaterals	6.2	0.24	9.0	0.29	8.1	0.27
Number of applications	1.8	1.07	2.0	1.26	2.0	1.20
Number of rejections	1.2	1.19	1.0	1.27	1.1	1.24
Rejection rates (%)	57.4	0.45	39.9	0.42	46.4	43.92
Reasons for rejection						
Inadequate guarantees (%)	56.0	0.51	61.5	0.50	0.6	0.50
Incomplete applications (%)	21.2	0.42	27.7	0.46	24.8	0.44
Access to credit - loans (%)	17.5	0.38	15.0	0.36	15.9	0.37
Interest rates	11.1	2.78	9.6	2.11	10.3	2.58
Duration (months)	29.3	34.66	31.8	36.99	31.4	35.67
Amount (mlnFCFA)	58.3	70.90	112.8	227.00	88.4	180.00
Share in financing need (%)	5.0	15.40	4.3	14.50	4.5	14.82
Share of self-financing (%)	73.5	36.9	82.6	30.2	79.3	33.0

Note: "S.D." stands for standard deviation.
Source: Authors' calculations, from survey data.

4 Application and results

Table 4 shows the distribution the non-parametric estimates of the efficiency scores, after the removal of close to 90 outliers. The estimated average efficiency is 0.203 or 20.3 percent; that is, the average firm has a total efficiency gap of close to 80 percent vis-à-vis the most efficient ones (its peers on the efficiency frontier). In addition, the smaller estimated median of 0.129 is indicative of a left-skewed distribution of the scores, further suggesting a log normal distribution as a good approximation of the data generating process. Figure 1 in the appendix shows the distribution.
The decomposition of total efficiency into the product of the two main components reveals that the main source of inefficiency has to do with the sectorial choice of activity and the organization and management of firms rather than scale (firm size).[5] In effect, the average inefficiency gap related to the quality of management is almost 75 percent, while inefficiency gap due to scale is less than 18 percent. This clearly indicates where to put more emphasis when exploring ways to improve efficiency of the production process.

[5] See Huguenin (2013), for more details on this decomposition and the interpretation of the results.

Table 4: Distribution of efficiency scores

	Total efficiency		Pure efficiency		Scale efficiency	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
Total sample	20.4	20.8	25.7	24.7	82.1	22.1
Credit						
Beneficiaries	18.1	17.1	27.1	22.4	72.7	26.0
Non-beneficiaries	21.0	21.5	25.6	24.9	83.8	20.8
Gender						
Female-owned	21.6	21.6	26.8	24.7	82.7	22.7
Male-owned	19.7	20.4	25.1	24.3	81.8	21.7
Size (categories)						
Small	23.1	22.7	25.0	23.6	90.2	13.4
Medium	13.5	12.4	25.0	22.3	61.7	24.2
Large	10.1	8.6	49.3	47.4	45.7	22.7
Sectors						
Agro-business (8)	16.9	9.3	26.9	10.1	63.9	26.3
Textiles/clothing (13)	14.4	9.1	18.9	11.7	82.7	24.2
Chemicals/non-metal (9)	14.2	8.3	27.5	25.1	69.5	28.8
Metal/machinery (21)	12.6	9.4	23.9	25.4	68.0	27.9
Technology/electronics (15)	16.7	11.3	17.7	10.8	91.9	10.9
Construction (28)	13.8	10.8	20.8	15.7	73.1	24.8
Trade/Retail (138)	34.3	26.8	36.9	28.2	91.6	11.9
Hotels/restaurants (29)	9.0	13.1	18.5	24.4	64.6	35.6
Transports (13)	9.9	6.6	23.8	28.3	64.0	27.1
Other services (159)	14.6	15.5	19.6	21.6	82.3	20.6
Other manufacturing (19)	17.2	11.7	20.0	12.8	86.2	11.2

Source: Authors' calculations. The efficiency scores, which range from 0 to 1, are turned into percent. Values between parentheses for the sectors represent the number of firms.

A further decomposition looks at the contribution of each input factor in efficiency of the production. Figure 2 provides a map of inputs and efficiency. It indicates that labor has greater contribution than capital: firms with greater labor intensity (or lower capital intensity) tend to be more efficient. Because labor is measured as total salary mass, one could hypothesize that skilled labor is key to firms' efficiency.
As far as total efficiency is concerned, Table 4 also indicates the main characteristics of the most efficient firms. They tend to be relatively small, in line with the average inefficiency gap of 18 percent due to scale. They tend to operate in sectors such as trade, where the typical firm has an efficiency score of 34.3 percent, that is, more than 70 percent higher than the average for the whole sample. Sectors with low efficiency include hotels and restaurants, transports, construction, and metal and machinery. It is interesting to note that in most efficient activities, relatively shorter production cycles (think of trade) are synonymous with greater profitability compare to their least efficient counterparts which production cycles tend to be longer.
These least-efficient sectors tend to have relatively higher capital intensity (capital over labor), compared to the most efficient ones. In effect, the two most efficient

sectors, namely, trade and agro-business, home to a third of the firms, have an average capital intensity of, respectively, 2.69 and 8.71 million FCFA per worker. On the opposite, the two least efficient sectors (hotel/restaurant and transport) have among the greatest capital intensity (70.8 and 14.5), and they represent close to 10 percent of firms.

In addition, capital intensity seems to be correlated with credit demand. In effect, firms operating in the three most intensive capital sectors (hotel/restaurant, chemicals/non-metals, and transport, with an average capital per labor ratio of 41.1 million FCFA) happen to have greater propensity to access to credit than the three sectors with the lowest capital intensity (technology/electronics, trade and construction, with an average capital-to-labor ratio of 3.2 million FCFA). The access rate is 22 percent for the former and 15 percent for the latter.

As a consequence, efficiency tends to be negatively associated with access to credit. In effect, the aforementioned three most capital-intensive, less-credit-constrained turns out to be less efficient than their three counterparts. Interestingly, Table 2 also indicates that firms with no access to credit exhibit greater efficiency than firms with access to credit: 21 against 18 percent. As a simple correlation, these figures simply say that credit tends to go to sectors that need more capital, which turn out to be the least efficient ones.

As far as gender is concerned, Table 4 also reveals that female-owned firms have greater efficiency than their male-owned counterparts: 21.6 against 19.1 percent. This could be related to the gender distribution across sectors. In effect, female tend to be more concentrated in sectors that happen to be the most efficient. In sectors with greater efficiency such as trade, technology/electronics, and agri-business, with an average efficiency score of 32.2 percent, women entrepreneurs represent 44.5 percent, which is above their average for the whole sample of 34 percent. Their share in less efficient sectors such as hotel/restaurant, transport, metal/machinery and construction, with an average efficiency of 11.8 percent, represents only 27.7 percent. So if female appear to be more efficient than male, it is because they tend to operate more in sectors with greater efficiency.

Table 8 in the appendix shows additional characteristics of the most efficient firms. They tend to be managed by individuals with no formal education level, which is the case in sectors that do not require higher skills such as trade or agro-business (the most efficient sectors). When it comes to geography, they are located in regions such as Kaolack and Thies, as opposed to Dakar and Saint-Louis. As it turns out, firms in the first two regions are more concentrated in the most efficient sector (trade), with a share of 41 percent and 37 percent, respectively. In addition, most efficient firms tend to be foreign-owned, as opposed to Senegalese-owned, which may follow the assumption that foreign firms tend to be more technologically-advanced. Whether these simple statistical correlations reveal true relationships require controlling for other covariates.

As a first approximation, we first run simple separate regressions, ignoring potential endogeneity and self-selection biases. Table 9 in the appendix shows the estimation results for firms' efficiency (linear model) and access to credit (a probit model). In both models, gender is not a significant explanatory variable, suggesting that female entrepreneurs are no more or no less likely to access to credit than male entrepreneurs, and there is no efficiency difference between female-owned firms and male-owned firms. Factors that matter for access to credit are manager's education, firms' ownership, sectorial activities, and whether they benefit from overdraft facilities. Factors such as manager's experience, firms' size, age, and employment structure, as well as geography and bank density in the department appear not to be significant discriminants between beneficiaries and non-beneficiaries of credit.

Correlates to firms' efficiency range from ownership to sectorial and geographic locations. The results also indicate that access to credit is not a significant determinant of efficiency, and its inclusion in the linear regression model as a regressor seems to bring no significant qualitative change in the overall estimation results (for instance, the signs of the coefficient estimates and the set of significant variables do not change). But if we believe the probit model that endogenizes access to credit, then the results may be plagued with biases that need to be corrected, using for instance the endogenous switching regression model. In such a model, the explanatory variables are not just correlates to access to credit or efficiency; they are drivers or generating mechanisms that underlie the observed outcomes.

The regression results of the endogenous switching model are shown in Table 5. The joint Wald independence test indicates the appropriateness of the empirical approach to modeling simultaneously access to credit and firms' efficiency rather than separately. In addition, one of the correlation coefficients, namely ρ_0, is significantly different from zero, which is indicative of a failure to reject the null hypothesis of sample selection bias and further validates the model. The correlation coefficient ρ_1 in the efficiency equation for firms that have access to credit is not significantly different from zero, implying that firms that are not constrained in the credit market do not have a higher or lower efficiency than a firm randomly selected from the sample. In contrast, the correlation coefficient ρ_0 is significant and negative in the equation for firms with no access to credit, indicating that those credit-constrained firms have a higher efficiency than the randomly selected firm from the sample. In other words, to the extent that these latter become less credit-constrained, then their efficiency would tend to decrease.

Table 5: Endogenous Switching Regression Model Estimation Results

	Log(efficiency): credit	Log(efficiency): no credit	Access to credit
Ownership characteristics:			
- Female owned-firms	0.00915	-0.00772	0.0801
- Experience of manager	-0.0110	-0.00773	0.00684
- No education	0.942*	-0.0686	-1.274***
Firm characteristics:			
- Senegalese-owned	-0.652	-0.446***	0.456
- Mixed-owned	-0.604	-0.438	0.442
- Age of firms	0.00739	-0.00425	0.000809
- Female workers: share	-0.00400	0.000458	-0.00500
- Number of workers	-0.00570	-0.00232	0.00416
Sectors:			
- Construction	-0.335	0.107	-0.770*
- Trade	0.769	0.818***	-0.454
- Other services	0.0263	-0.238*	-0.405
Regions:			
- Dakar	0.417	0.121	-0.438
- Kaolack	0.788	0.849***	
- Thies	0.633	0.291*	
Instruments:			
- Interest rate on credit line, by dept.			0.236
- Interest rate on loans, by dept.			0.015
- Credit access rate, by dept.			0.014
- Overdraft facility			1.549***

Constant	-1.119	-1.675***	-6.070
Observations	416		
Wald chi2 (significance)	46.8***		
Sigma 1	0.732		
Sigma 0	0.815***		
Rho 1	-0.534		
Rho 0	-0.317*		

Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Wald test of independent equations: chi2(1) = 3.57, and Prob(chi2) = 0.0588

This result is not in line with those in Khan et al. (2013) for Pakistan or in Nwaru and Onuaha (2010) for Nigeria who suggest that access to credit has no positive impact on performance; in some instances, it even generates adverse effects. The positive association between access to credit and efficiency in Senegal could mean than the reasons invoked in both of these countries (lengthy procedure of getting credit, inappropriate loan schemes in terms of high costs, as well as long delays of credit disbursement) may not perfectly pertain to the country's context, or at least not to the same extent. Or it could be that firms are more able to make the best use of the funding provided by the financial institutions.

When it comes to gender, the results for the selection model clearly indicate that there is no such thing as gender-based discrimination in the credit market. The positive sign of the coefficient estimate on gender even suggests that female entrepreneurs may have greater chances to access to credit, although the magnitude turns out to be quite marginal. This result is, at first glance, not in line with that of Asiedu et al. (2013) who found that female entrepreneurs are discriminated against in Africa (but not in other parts of the developing world). It is close to that of Hansen and Rand (2011) who found that women are rather less credit constrained than male in the continent. In these studies, Senegal was one data point in the whole pool of countries. Our more context-oriented "point" estimate can then be part of their "average" estimate, and could be more telling of the functioning of the specific credit market in the particular case of Senegal.

The likelihood to access to credit is greater for firms with highly educated managers, operating in sectors other than construction, and benefitting from bank overdraft facilities. Education can in fact help entrepreneurs familiarize with the application process; capital-intensive sector of the like of construction are more likely to both exhibit greater demand for credit, which could translate, for a given credit worthiness, into greater chances to access to credit; and overdraft facilities could be indicative of lower financial risk of the beneficiaries which could then be more successful when it comes to credit application. Factors such as firms' size, ownership, and geographical locations do not matter significantly in determining firms' likelihood to access to credit.

When it comes to efficiency, there are again no gender-based differences. In effect, in both efficiency equations, the coefficient estimate on gender is not significantly different from zero, implying that whether they have access to credit or not, female-led firms are neither better nor worse than their male-led counterparts.

Furthermore, there are noticeable differences in the coefficient estimates between the two efficiency equations, implying that the potential drivers of efficiency have varying effect on the efficiency of a firm depending on whether it has access to credit or not. For instance, education seems to matter only for less-constrained firms, in the sense that those whose managers have no education have greater efficiency than the random firm.

In addition, there is a significant difference between foreign-owned firms and Senegalese-owned firms, efficiency-wise, only to the extent that the latter have no access to credit. In such a situation, foreign firms are less efficient than their domestic counterparts. The efficiency gap narrows and becomes no significantly different from zero when the domestic firms get access to credit. Loosening the credit constraint on domestic firms then has the potential to allow the latter to successfully compete with their more technologically-advanced counterparts and close the efficiency gap.

There are also geographical differences in firms' efficiency, but only for credit-constrained firms. When credit is available, firms in one region do no better or no worse than firms located in other regions. But with no access to credit, they tend to do worse in Saint-Louis, and to a lesser extent, in Dakar, than in Kaolack and Thies. The result confirms the efficiency gap in favor of the latter region found in the descriptive statistics, even after controlling for various differences, such as sectorial differences. It is an indication that firms in these two regions are more resilient to the lack of financial support, for instance by using a production technology or opting for a type of activity that relies more on labor than on capital. The data show in fact that firms located in these two regions have the lowest capital intensity. To the extent that (skilled) labor seems to contribute more to efficiency than capital, as shown in Figure 2, then this explains the geographical differences in firms' efficiency.

Finally, efficiency differences viewed as treatment effects are shown in Table 6. They are obtained from the conditional expectations of the mean efficiency from the switching regression models and from the propensity score matching techniques. Positive and significant estimates of the treatment effect on the treated (ATT) and on the untreated (ATU) from the regression predictions indicate that both groups benefit from access to credit: efficiency is indeed greater for less credit-constrained firms because of their access to credit than it would have been had they not benefitted from credit; and firms with no access to credit would have gained more efficiency had they benefitted from credit. For credit-beneficiary firms, the actual return to access to credit is a 5.7-percent increase in efficiency, and for non-beneficiaries, the gain would have been 20.4 percent. The decomposition into the different effects shows that the positive link for the treated group is mainly explained by the *return effect (RE)* or in some words, the difference in estimated coefficients of explanatory variables. In contrary, the *selection effect (SE)* component continues to contribute negatively for the treated group.

As for the effects from the matching comparison, the results overall indicate that access credit does not yield any efficiency gain for both groups, at best, even after ignoring the balancing property and so as to consider the same set of explanatory variables and make the results comparable with those of the switching model. The difference between these two sets of results tells about the relative importance of non-observable factors, which are not smoothed in the PSM. The latter in fact is based on the assumption that any difference between the two groups is solely based on observable factors (CIA condition). The significant change in the estimates of the treatment effect when this assumption is relaxed is clearly an indication that unobservable factors do indeed matter, as suggested by the failure to reject the hypothesis of sample selection bias in the switching regression model.

Table 6: Average treatment effect estimates

	ESRM				PSM					
					With balancing constraint			No balancing constraint		
	Effect on (theta)	*Effect on log (theta)*	*RE*	*SE*	Neighbor	Caliper	Kernel	Neighbor	Caliper	Kernel
ATT	0.057***	0.467***	0.605***	-0.139***	-0.017	-0.133	-0.04	0.008	-0.013	-0.037
ATU	0.204***	0.767***	0.742***	0.0252	-0.026	-0.059	0.003	-0.014	-0.036	-0.011
N	416	416	416	416	439	439	439	416	416	416

Notes: Standard errors in parentheses are obtained through bootstrapping for the PSM, with 600 replications. The range in the nearest neighbor is 5, and the radius in the caliper matching is 0.02 in both cases. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Overall, access credit does bring efficiency gain. To the extent that there is no gender based-discrimination in the credit market, female-owned firms are no more or no less efficient than their male-owned counterpart, neither as a result of credit nor as a result of any non-observable, intrinsic, gender-related characteristics. These results hold when "pure" efficiency is considered, as shown in Table 8 in the appendix. The similarity of the results may be due to the fact that "total" inefficiency mainly originates in poor management and organization of firms, captured by "pure" efficiency scores, as discussed previously and indicated in in Figure 2.

As shown by the PSM approach, the negative linkage between access to credit and efficiency is driven mainly by inter-sectorial efficiency gaps and their real need for the credit, which depends mainly on capital intensity. Even if the number of observations within each sector is small and do not enable to check the nature of intra sectorial linkage with advanced econometric models, the descriptive statistics indicate the positive linkage between the access to credit and efficiency for sectors with intensive capital use.

5 Conclusions and policy implications

Two noticeable trends in female entrepreneurship in Senegal in the last decade have been an increase in the share of female-owned firms, and an equally significant rise in female entrepreneurs' share in new start-ups. In conjunction with greater impact of female-owned firms when it comes to employment and poverty reduction than their male-owned counterpart, these patterns somehow contrast with the wide belief that female entrepreneurs are discriminated against in the credit market, reducing the pace of such positive trends. This belief has prompted many policy responses aiming at providing more favorable loans conditions to the females. But whether these public policies would be successful depends crucially on the extent to which such belief is based on solid empirical ground.

This paper was concerned with empirically investigating whether there is gender-based discrimination and how it may be translated into any performance differential. Using on firm-level data, the paper developed a two-part methodology which first computed "overall" efficiency using data envelopment analysis, and then related the efficiency scores to a large set of firms and credit market characteristics, using various approaches, such as an endogenous switching regression and matching comparison techniques.

The results clearly indicate that there is no such thing as gender-based discrimination when it comes to access to credit in Senegal: female entrepreneurs firms are no more or no less likely to obtain credit than their male counterparts. In addition, extending credit to credit-constrained firms as well as to firms that already benefit from credit leads to increased efficiency for both male-owned and female-owned firms, and the former do not reap any greater or smaller returns from credit than the latter.

The finding that gender is not a significant discriminant to access to credit and efficiency may not however be an indication that female-oriented public policies aiming at improving access to credit or promoting entrepreneurship should be called off. Rather, the narrative behind such policies need be adjusted. Their rationale should come from the large discrepancy between the large share of female in the general population (more than 50 percent) and their rather small contribution to the business world (about one in three firms are female-owned). This may suggest that some elements in the business climate other than the ease of access to credit might have some adverse effects on female entrepreneurship. The fact that female entrepreneurs are on average more educated than their male counterparts (70 percent have higher education, against 48 percent) is indicative that social and cultural norms still require greater skills for women to equally succeed in business than men. Additional research may be needed to identify how these institutional norms manifest themselves into specific elements of the business climate. Succeeding to do so would guide policies in the design of their gender component and contribute to expand the productive base of the economy.

The positive effect of access to credit on efficiency, as well as the relatively low access rate (15.9 percent) and the small contribution of credit to firms' financial need (4.5 percent) imply that there are still great potentials to expanding firms' efficiency for male and female alike. The first set of policies would focus on improving access to credit. Familiarizing entrepreneurs with loans application procedure would bring more firms into the credit market, as well as helping with collaterals. A clear emphasis has to be put on the type of activity of firms, mainly firms with intense use of capital. The Senegalese government has initiated policies in these directions. One is the advent of a couple of public agencies that help firms familiarize with best business practices: *Agence Nationale de Mise a Niveau des Entreprises – ANMNE*", and "*Agence de Developpement de la Petite et Moyenne Entreprise – ADPME*". Furthermore, there is a newly found public "*Fonds de Garantie des Investissements Prioritaires – FONGIP*" by which the government essentially acts as co-signee alongside firms in their loan application. The fact that firms still invoke inadequate collaterals, incomplete credit application and burdensome procedures suggests that there is still a long way to go.

Improving efficiency of these institutions in reducing the credit market constraints would also require adding a sectorial component by focusing on those that suffer the most, such as firms operating in the construction sectors. In addition, these policies need not include a regional component, as the credit constraints play out similarly across the various geographical locations. Furthermore, to the extent that low-educated managers are successfully convinced that the various services provided by the aforementioned public agencies can improve their likelihood to access to credit, those agencies would gain further efficiency.

When it comes to improving firms' efficiency, these same public institutions can also play an important role. For instance, efficiency seems to be originated mostly in the organization and management of firms, as shown in Figure 2. With (free or low-fee) training programs that strengthen business practices of entrepreneurs, those institutions could make a difference. This is particularly the case as the formal education seems to fail managers (less educated managers appear to outperform highly-educated ones). The training programs could for instance target young entrepreneurs who freshly graduate from the ever-expanding business school landscape, and focus on regions such as Dakar and Saint-Louis and on sectors other than trade.

In addition, since Senegalese-owned firms appear to lag behind their foreign-owned counterparts, and to the extent that the latter are a great source of technology transfer, public policies need to encourage foreign investment, while improving the channels through which technology diffuses to the rest of the economy, thereby narrowing the gap with Senegalese firms. In addition to facilitating access to credit, policies that improve the working of the diffusion technology channels need to be considered, such as greater mobility of the labor force from one sector (foreign) to another (Senegalese). Exploring these various policy options and improving the efficiency of public agencies that deal with firms could have the potential to improve both male and female entrepreneurship through greater access to credit and more efficient firms.

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Appendix

Table 7: Access to credit and gender across firms' characteristics

	Access to credit		Female-owned		Total sample	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
Sectors						
Agro-business	0.0	0.00	49.0	0.53	2.1	0.14
Textiles/clothing	4.1	0.21	43.7	0.52	1.7	0.13
Chemicals/non-metal	32.2	0.50	16.1	0.39	2.1	0.14
Metal/machinery	46.5	0.51	1.6	0.13	4.4	0.21
Technology/electronics	24.4	0.44	38.5	0.50	2.3	0.15
Construction	21.9	0.42	27.7	0.46	7.9	0.27
Trade	11.9	0.33	44.7	0.50	31.3	0.46
Hotels/restaurants	7.6	0.27	52.5	0.51	4.9	0.22
Transports	34.4	0.49	26.2	0.46	3.5	0.18
Other services	13.0	0.34	34.3	0.48	35.2	0.48
Other manufacturing	23.6	0.44	14.8	0.36	4.6	0.21
Labor						
Small	11.1	0.31	36.2	0.48	74.7	0.44
Medium	30.8	0.46	32.2	0.47	22.6	0.42
Large	31.7	0.49	43.5	0.52	2.7	0.16
Number of workers	34.6	39.2	19.8	32.2	19.9	33.1
Share of female workers	24.1	21.8	39.2	24.7	28.9	22.8
Regions						
Kaolack	31.8	0.48	31.8	0.48	0.4	0.07
Thies	13.7	0.35	27.8	0.45	3.9	0.19
Dakar	16.4	0.37	36.2	0.48	93.1	0.25
Saint-Louis	7.2	0.26	18.9	0.39	2.5	0.16
Manager's experience	19.2	9.5	18.3	8.7	18.9	9.3
Education						
None	5.6	0.23	21.6	0.42	2.8	0.17
Primary	19.2	0.40	5.3	0.23	6.5	0.25
Secondary	12.4	0.33	29.5	0.46	14.6	0.35
Higher	19.7	0.40	44.8	0.50	56.0	0.50
Technical/professional	10.2	0.31	26.9	0.45	15.8	0.37
Ownership						
Senegalese-owned	17.3	0.38	35.1	0.48	82.0	0.38
Mixed-owned	23.2	0.43	39.7	0.50	5.7	0.23
Foreign-owned	3.0	0.17	35.3	0.48	11.0	0.31
Age	14.2	11.6	16.2	11.4	14.8	11.0

Note: "S.D." stands for standard deviation.
Source: Authors' calculations, from survey data.

Figure 1: Kernel density estimate of efficiency scores (turned into percent)

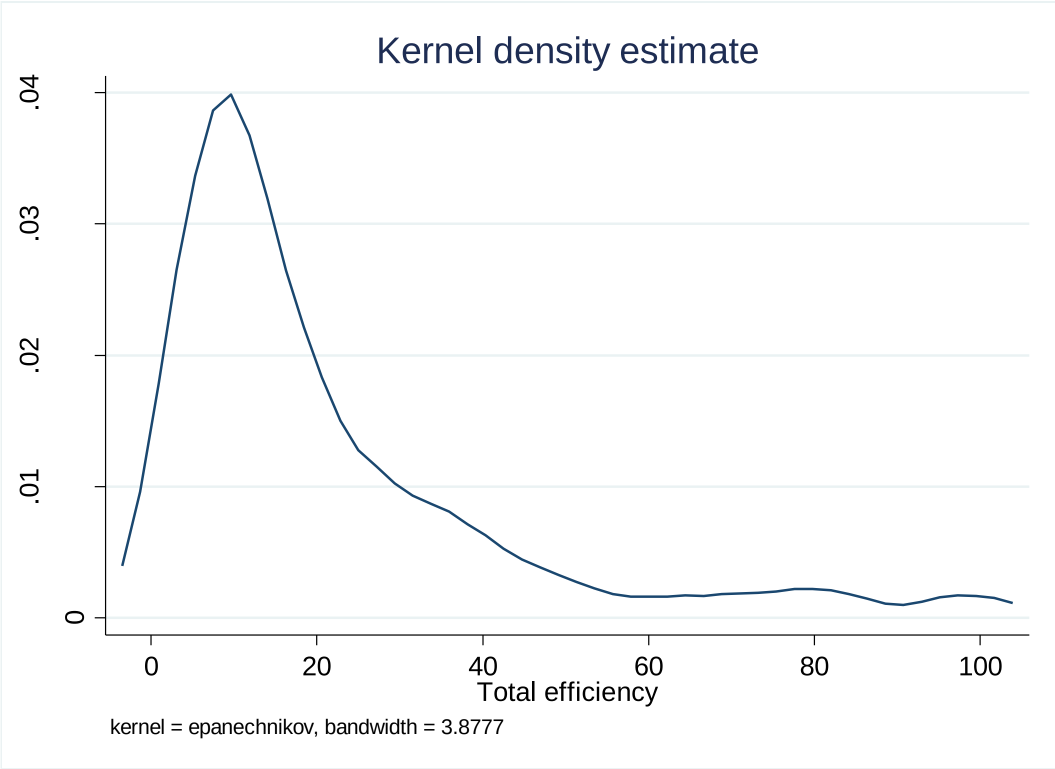
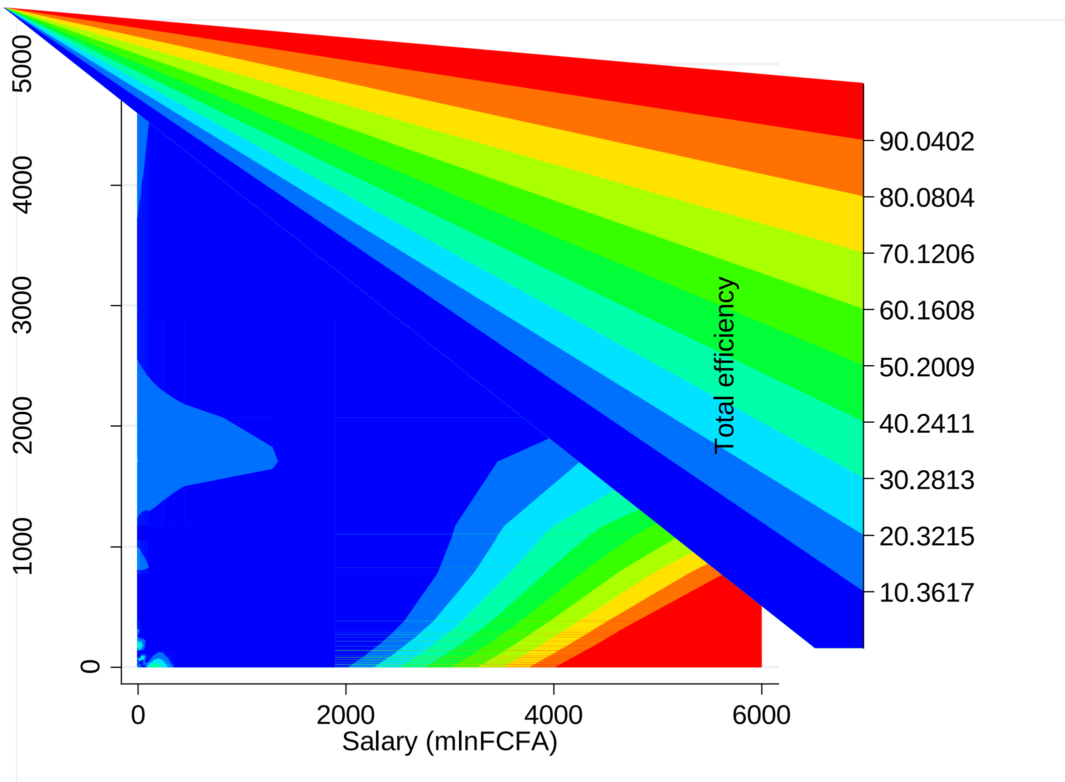


Figure 2: Efficiency map



Note: Efficiency scores are turned into percent.

Table 8: Detailed efficiency distribution across firms' characteristics

	Total efficiency		Pure efficiency		Scale efficiency	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
All firms	20.4	20.8	25.7	24.7	82.1	22.1
Credit						
Beneficiaries	18.1	17.1	27.1	22.4	72.7	26.0
Non-beneficiaries	21.0	21.5	25.6	24.9	83.8	20.8
Gender						
Female-owned	21.6	21.6	26.8	24.7	82.7	22.7
Male-owned	19.7	20.4	25.1	24.3	81.8	21.7
Size (employment)						
Small	23.1	22.7	25.0	23.6	90.2	13.4
Medium	13.5	12.4	25.0	22.3	61.7	24.2
Large	10.1	8.6	49.3	47.4	45.7	22.7
Education						
None	28.9	22.0	33.2	25.8	92.8	14.9
Primary	12.8	20.5	14.4	20.3	85.3	17.2
Secondary	19.6	16.4	25.8	23.7	83.1	23.5
Higher	23.4	23.6	29.4	26.6	80.9	23.1
Professional-techn.	13.7	10.8	17.4	16.3	83.8	17.3
Ownership						
Foreign	24.1	20.9	29.5	23.9	80.0	22.6
Senegal	20.2	21.4	24.9	24.4	83.3	21.5
Age						
Above average	21.2	21.8	27.9	26.0	78.6	23.8
Below average	19.9	20.3	24.4	23.5	84.1	20.8
Regions						
Dakar	20.2	20.8	25.6	24.5	81.6	22.3
Thies	43.7	30.8	49.2	31.1	87.3	16.4
Saint-Louis	17.7	14.4	18.7	14.6	93.1	13.7
Kaolack	24.8	22.5	29.0	25.4	86.6	17.3
Sectors						
Agro-business	16.9	9.3	26.9	10.1	63.9	26.3
Textiles/clothing	14.4	9.1	18.9	11.7	82.7	24.2
Chemicals/non-metal	14.2	8.3	27.5	25.1	69.5	28.8
Metal/machinery	12.6	9.4	23.9	25.4	68.0	27.9
Technology/electronics	16.7	11.3	17.7	10.8	91.9	10.9
Construction	13.8	10.8	20.8	15.7	73.1	24.8
Trade	34.3	26.8	36.9	28.2	91.6	11.9
Hotels/restaurants	9.0	13.1	18.5	24.4	64.6	35.6
Transports	9.9	6.6	23.8	28.3	64.0	27.1
Other services	14.6	15.5	19.6	21.6	82.3	20.6
Other manufacturing	17.2	11.7	20.0	12.8	86.2	11.2

Figure 3: Efficiency and gender across sectors

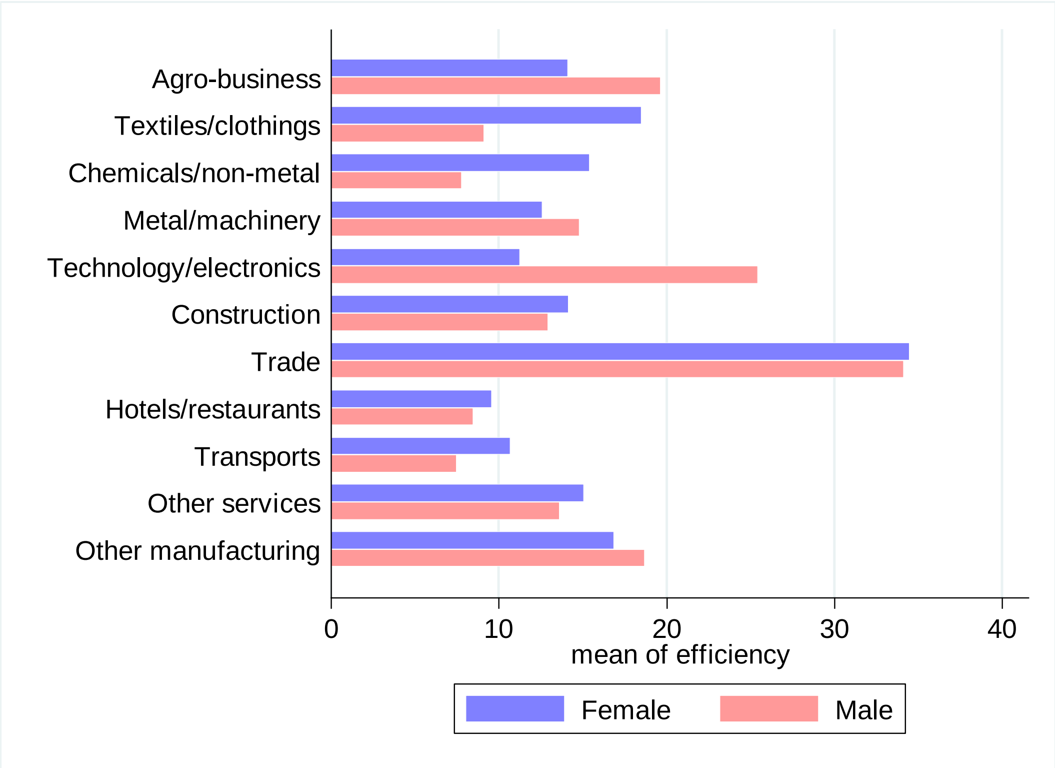


Figure 4: Efficiency and access to credit across sectors

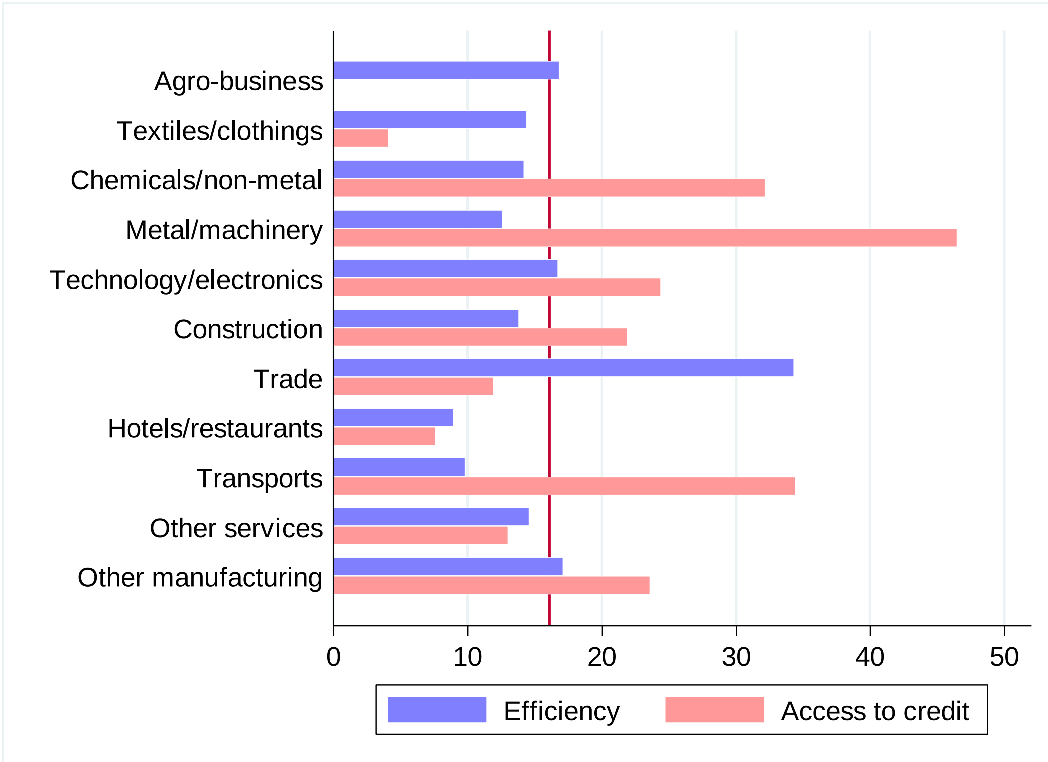


Table 9: Efficiency and access determinants (GLS, probit and marginal effects)

	Log(efficiency): GLS	Log(efficiency): GLS	Access to credit: probit	Access to credit: marginal effect
Ownership characteristics:				
- Female owned-firms (d)	-0.0263	-0.0311	0.3345	0.0567
- Experience of manager	-0.0046	-0.0046	-0.0057	-0.0009
Levels of education:				
- Primary (d)	-0.3286	-0.3395	1.4780**	0.4352*
- Secondary (d)	0.0815	0.0756	1.1675*	0.2967
- Higher (d)	0.1493	0.1376	1.3876**	0.2095**
- Technic/professional (d)	-0.0640	-0.0675	1.1036*	0.2703
Firm characteristics:				
- Senegalese-owned (d)	-0.4295**	-0.4374***	0.6761	0.0793*
- Mixed-owned (d)	-0.3990	-0.4082	0.4426	0.0897
- Age of firms	-0.0038	-0.0037	-0.0001	-0.0000
- Female workers: share	-0.0001	-0.0000	-0.0038	-0.0006
- Number of workers	-0.0019	-0.0020	0.0044	0.0007
Sectors:				
- Textiles/clothing (d)	-0.0636	-0.0743	4.2008***	0.9211***
- Chemicals/non-metal (d)	-0.0071	-0.0321	4.9714***	0.9290***
- Metal/machinery (d)	-0.2110	-0.2441	4.9647***	0.9439***
- Technology/electronics (d)	-0.0250	-0.0482	4.9325***	0.9298***
- Construction (d)	-0.0120	-0.0295	4.2480***	0.9496***
- Trade (d)	0.6181	0.6069	4.0382***	0.9174***
- Hotels/restaurants (d)	-1.0660**	-1.0744**	3.9115***	0.9313***
- Transports (d)	-0.4853	-0.5066	4.0919***	0.9295***
- Other services (d)	-0.2177	-0.2254	3.9310***	0.8823***
- Other manufacturing (d)	0.2274	0.2094	4.3009***	0.9351***
Region:				
- Dakar (d)	-0.7939***	-0.7822***	-0.4918	-0.1019
- Saint-Louis (d)	-0.8408***	-0.8240***	-0.3854	-0.0473
- Thies (d)	-0.6408**	-0.6280**	-0.4989	-0.0573
Others				
- Access to credit		0.0683		
- Bank density (per firms, by dept.)			0.3512	0.0557
- Overdraft facility (d)			1.3261***	0.3286***
Observations	429	429	429	429
R^2	0.318	0.319		
Pseudo R^2			0.296	0.296

Note: (d) for discrete change of dummy variable from 0 to 1
Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Endogenous Switching Regression Model, with "pure" efficiency scores

	Log(efficiency): credit	Log(efficiency): no credit	Access to credit
Ownership characteristics:			
- Female owned-firms	-0.0651	0.0616	0.0895
- Experience of manager	-0.0071	-0.0104	0.0049
- No education	0.7805	0.0482	-1.1664***
Firm characteristics:			
- Senegalese-owned	0.5411	-0.4546***	0.3031
- Mixed-owned	0.7998	-0.5095	0.1991
- Age of firms	0.0085	0.0013	0.0007
- Female workers: share	-0.0064	-0.0004	-0.0052
- Number of workers	0.0031	0.0033	0.0037
Sectors:			
- Construction	-0.1463	0.0519	-0.8375*
- Trade	0.5910	0.6703***	-0.5769*
- Other services	-0.0804	-0.2344*	-0.4974*
Regions:			
- Dakar	0.0617	0.2208*	-0.1683
- Kaolack	0.5169	0.8167***	
- Thies	0.2783	0.3269**	
Instruments:			
- Interest rate on credit line, by dept.			0.1418
- Interest rate on loans, by dept.			-0.0600
- Credit access rate, by dept.			-0.0130
- Overdraft facility			1.6484***
Constant	-1.9220	-1.6350***	0.4893
Observations	416		
Sigma 1	0.7595		
Sigma 2	0.7958***		
Rho 1	-0.3436		
Rho 2	-0.5939*		

Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Wald test of independent equations: chi2(1) = 4.09, and Prob(chi2) = 0.0422