Firm Performance Under Financial Constraints: Evidence from Sub-Saharan African Firms

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Abstract

Business environment in which a firm operates has an important impact on firm performance. This study examined the impact of credit constraint and power outages on the firm's investment decision using World Bank Enterprise Survey data collected from firms operating in 13 SSA countries. The study employed a two-part model and the Heckman selection model to estimate the impact of lack of access to finance and poor power supply on a firm's decision to invest in self-generation. The result obtained suggest that there is a negative correlation between credit constraint and a firm's decision to invest in self-generation. This indicates that credit constraint negatively affects a firm's decision to invest in self-generation and firms that are credit constrained have less incentive to invest in self-generation compared to those that are not credit constrained. To test the robustness of the result obtained, alternative definitions of credit constraints were used. Results from alternative regressions using different definitions of credit constraints show that credit constraint affects a firm's decision to invest in self-generation but not the volume of investment.

1. Introduction

It was established in the literature that business environment-encompassing features of legal and regulatory services, infrastructure, financial and institutional systems of the country affect firm performance and the entrepreneur's willingness to invest (Abdisa, 2019). According to Essmui et al. (2014), a good business environment makes a country an attractive destination for foreign investment and a place in which domestic entrepreneurs of all sizes and across industries are willing to invest. Cross-country empirical studies also show that strong evidence that the underdeveloped business environment is associated with a poor investment, employment, and economic growths (Escribano et al., 2009; Hansen, 2014; Harrison et al., 2014).

Firm performance is strongly linked to the availability and access to finance, which is a main component of the business environment in which firms operate. Empirical studies showed that the degree to which firms face financial constraints mainly depends on firm size- small firms face bigger challenges in obtaining finance as compared to larger firms (Schiffer and Weder, 2001; Beck et al., 2002; Abdisa, 2018). This further magnifies the relative impact of the financial constraints on the firm's investment decision. In this regard, a study by OECD (2006) documented that access to finance allows firms to expand their business activities and grow faster.

However, the problem of financial constraint and its effect on firm performance significantly varies across regions and countries. For example, Fowowe (2017) showed that financial constraint is the main problem for African countries than in other developing countries, posing a significant challenge to firm growth and further investment decisions. The author, based on the survey data of 26 African countries, found that lack of access to finance was a major constraint among firms operating in SSA countries. The author also noted that within SAA firms, those that have better access to finance have better growth experience, growth being measured by the number of permanent full-time workers. In this regard, about 60% of the

sample firms used in this study are reported to be financially constrained, suggesting that financial constraint is the main obstacle to firm performance in SSA countries.

In addition to lack of access to finance, the poor power supply is also the main obstacle to firms' doing business in SSA. The World Bank Enterprise Survey (WBES) report in 2007 shows that the average Sub-Saharan African firm suffered a loss of economic activities for around 77 hours per month due to power outages. The situation is even worse in some countries and particularly when compared with other developing regions of the world. The WBES report relating to 2010/2011 shows that about 22% of business managers consider electricity as the most serious obstacle to doing their business (Word Bank, 2015). Many empirical studies have been devoted to examining the impact of poor supply on firm performance and the strategies that firms adopt to cope with the poor power supply (Steinbuks and Foster, 2010; Nyanzu and Adarkwah, 2016; Adenikinju, 2003; Oseni and Pollitt, 2015; Iacovone et al., 2014; Abdisa, 2018 and Abdisa, 2020). In this regard, empirical studies by (Beenstock et al., 1997, Oseni and Pollitt, 2015 and Abdisa, 2020) found that firms that invested in self-generation continue to face higher unmitigated loss which shows that firms make only partial investments which cannot fully backup back up their electricity load.

Our contribution complements the above empirical evidence. Specifically, the study provides answer to the question "why do firms that invested in self-generation continue to face outage loss?" However, unlike the studies cited above, our study contributes to the existing literature in three important ways. First, the existing empirical investigation by Beenstock et al. (1997); Oseni and Pollitt (2015) and Abdisa (2020) predicted that investment in self-generation of electricity does not guarantee complete mitigation of power outages and a firm that invested in self-generation may continue to face outage loss. However, it is not clear from these studies that why do firms that invested in self-generation continuous to face outage loss? Second, we deviate from many existing literature by exploring factors behind the firm's sub-optimal investment in self-generation using firm-level data for SSA countries and hence we offer new insights in understanding the performances of firms operating in SSA countries. Finally, examining the impact of access to finance and power outages pose a significant identification challenge due to the potential reverse causality bias, as firms with poor investment opportunities are expected to have a higher probability of being credit constrained (Fowowe, 2017). To tackle this challenge, several identification strategies were employed in this study using the two-part model and Heckman selection model (1979).

In nutshell, we explored the joint effect of the lack of access to finance and the poor supply of electricity on a firm's incentive to invest in self-generation. The result obtained suggest that there is a negative correlation between credit constraint and a firm's decision to invest in self-generation. This indicates that firms that are credit constrained have less incentive to invest in self-generation compared to those that are not credit constrained. Results from alternative regressions using different definitions of credit constraints show that credit constraint negatively affects a firm's decision to invest in self-generation. In particular, credit constraint affects a firm's decision to invest but not the volume of investment. This shows result obtained is insensitive to the alternative definitions of credit-constrained used indicating the robustness of the result obtained

The remaining part of the paper is organized as follows: Data source and descriptions, estimation strategies, and the empirical models are discussed in Sect. 2. Section 3 presents empirical results, while conclusions and policy implications drawn from the study are presented in Sect. 4.

2. Methodology

2.1. Data

The study employed the World Bank Enterprise Survey (WBES) which is collected from business enterprises operating in 13 SSA countries. The WBES was collected from manufacturing and service in every region of the world including SSA countries. Even though the WBES covers different themes related business environment, the data utilized in this study relates to firms' perceptions related to doing their business, the relative significance of various constraints to firms' business operations which are mainly under the infrastructure and services theme of the survey.

The WBES provides an array of economic data on more than 140,000 firms in more than 141 countries worldwide. The data used in this study is, however, restricted to selected firms operating in 13 SSA countries .These countries were selected based on the number of firms included in the survey and the year the survey was conducted. Accordingly, this study considered only countries for which the survey was conducted after the year 2010 and countries for which data on at least 100 firms are available after cleaning for missing information.

Combining firm data for 13 SSA countries selected for this study yields 5129 observations. However, data analysis was made with 3594 observations after cleaning the dataset for missing values and outliers.

The main advantage of using the WBES is that the survey uses standardized survey instruments and the same sampling methodologies across countries. This minimizes measurement error and yields data that are comparable across different economies. This is important to capture cross-country variation in the business climate and its impact on firm performance.

2.2. Variables and Descriptive Statistics

Alternative definitions of credit constraints are used and discussed in this section.

a) Perception approach

In the perception approach to credit constraint, firms are asked to rate the degree to which lack of access to finance is an obstacle to doing their business (Beck and Demirguc-Kunt, 2006; Asiedu et al., 2013). In the WBES, firms are given a categorized choice from no obstacle to a very severe obstacle. Following the approach in Hansen and Rand (2014) and Asiedu et al (2013), two versions of credit constraint variables are constructed from a firm's response to this question. The first is a categorical variable– *constraint*– which takes a value ranging from 0 to 4 in which higher value implies that the firm is more credit constraint. The second is a dummy variable– $constraint_a$– which equals 1 if the firm has reported access

to finance is a moderate, major and very severe constraint to doing its business and zero otherwise (details are reported in Table A.1 in the annex).

Table 1
Description and Definition of Variables

Variable	Description	Mean	Std. Dev.	Obs.
Outage(*lnH*)	Outage time in days/year	1.51	1.46	3488
G_{ow}	Generator ownership	0.64	0.48	3591
G_{sh}	Share of electricity from self-generation	0.33	0.28	2230
lnAge	Age of a firm (years)	2.51	0.703	3505
PID	Power intensity dummy	0.55	0.49	3594
Ownership	Percentage of firms owned by foreigners	0.16	0.36	3594
Export	Percentage of firms engaged in export	0.15	0.36	3594
Constraint	Finance as obstacle to doing business	1.93	1.30	3570
$Constraint_a$	1 if the firm is credit constraint	0.37	0.48	3594
$Constraint_1$	1 if the firm is credit constraint	0.47	0.49	3055
$Constraint_2$	1 if the firm is credit constraint	0.58	0.49	3594

The variable constraint is the firm's response to the question "to what degree lack of access to finance is an obstacle to doing your business". This a categorical variable taking a value ranging from 0 to 4. The variable "constraint_a" is dummy variable version of the variable "constraint" in which firms are classified as credit constrained if they have responded to the above question as a moderate, major, and severe constraint. While variables constraint_1 and constraint_2 are the alternative definitions of credit constraint defined in alternative b and c, respectively.

b) Credit application information

Based on the credit application information, firms are classified as credit constrained or not based on whether they have applied for a loan and the stated reasons for not applying. In the spirit of Bigsten et al (2003), and Hansen and Rand (2014), a firm is classified as credit constrained– $constraint_1$ – if: (i) the firm has applied for a loan and was denied, (ii) did not apply for a loan due to reasons such as "application procedures was complex", "collateral requirements were too high", or "possible loan size and maturity were insufficient". If a firm did not apply for a loan because it does not need one or applied for a loan and were approved, the firm is classified as unconstrained (see Table A.2 for details).

c) Use of financial services

Some studies (Aterido et al, 2013; Muravyev et al, 2009) use the firm's use of formal financial services as an indicator of credit constraint. According to this approach, firms that use formal financial services are classified as credit unconstrained while firms that do not use formal financial intuitions are classified as credit constrained. Following the same logic, this study also classifies firms that use formal financial institutions as credit unconstrained and others as credit constrained.

Table (2) classifies firms in the sample as credit constraint or not according to the three definitions the credit constraint given above. Using the first and third definitions, about 59% of firms are credit constrained while 47% of firms are credit-constrained based on the direct credit application information. The credit application information criterion resulted in a relatively less percentage of credit constrained firms compared to the other two.

The classification of firms as credit-constrained and unconstrained by firm size shows that a relatively higher percentage of large firms are credit unconstrained while a large share of small firms were found to be credit constrained. This shows that large firms are more likely to have access to external funds to finance their operations and hence less credit constrained than small firms.

Table 2
Classification of Firms by alternative definition of credit Constraint

Definition	**Constrained**	**Unconstrained**	**Total**
Perception approach	2119 (59)	1475(41)	3594
Credit application information	1446 (47)	1609 (53)	3055
Use of formal financial institutions	2113 (59)	1481(41)	3594
Firm Size	**Small**	**Medium**	**Large**
Percentage of Constrained	62.90	56.94	48.51
Percentage of Unconstrained	37.10	43.06	51.04
Figures in brackets are percentages. The perception approach is used to classify firms as credit-constrained and unconstrained.			

Outage time (lnH **)**

The variable outage time utilized in the study is computed from the reported frequency and duration of power interruptions that a firm faces in a month. A monthly outage time is obtained by multiplying the frequency of power outages with its duration and then it is converted into yearly data assuming the same outage frequencies and duration throughout the year. The outage time–the number of days a firm is without power supply from the public grid–also measures the reliability of power supply.

Furthermore, a correlation between different definitions of credit constraint and the firm's decision to invest in self-generation is examined and the result is reported in Table 3. The correlation matrix shows a meaningful result in which all measures of credit constraint are negatively correlated with both firm's

decision to invest and the volume of investment a firm wishes to invest. On the other hand, a power outage is positively correlated with both firm's decision to invest and volume of investment which implies that unreliable power supply induces firms to invest in private substitutes. Moreover, the Table shows that positive and significant correlation between the alternative definitions of credit constraints which imply the consistency of the alternative measures of credit constraint used.

Table 3
Correlation Matrix

Variables	G_{ow}	G_{sh}	*Constraint*	$Constraint_a$	$Constraint_1$	*Outage*(*ln*)
G_{ow}	1					
G_{sh}	0.571***	1				
Constraint	-0.109***	-0.103***	1			
$Constraint_a$	-0.105**	-0.093***	0.847***	1		
$Constraint_1$	-0.061***	-0.034**	0.338**	0.296**	1	
Outage(*ln*)	0.216***	0.506***	0.106**	-0.114***	0.028	1

*Constrain*t- is the perception approach to credit constraint definition and takes value from 0 to 4 with higher value implies more credit constraint, $constraint_a$ is the binary version of the variable "*Constrain*t" and takes the value of one if a firm reported access to finance is moderate, major and severe constraints to doing business.$Constraint_1$ is the credit application information definition of credit constraint and takes 1 if the firm is credit-constrained and 0 otherwise. Outages are the total power interruption in days a firm faces in a year.

2.3. Model specification

The methodology used in this paper is based on a theoretical model of a firm's investment decision by Abdisa (2020) where a similar approach was used in estimating the firm's investment decision. According to the approach in Abdisa (2020), all costs of investment in self-generation are weighted against the expected future benefits. This is based on the Net Present Value (NPV) approach to investment decisions and a firm undertakes an investment with a positive NPV.

In order to examine the role of access to finance in a firm's investment decision, we included financial constraints in the cost component of the firm's NPV computation. The implication is that a high financial barrier increases a firm's borrowing cost which worsens the NPV of the investment. Based on the NPV of the investment, a firm decides whether to invest in self-generation; and how much to invest. The first question is a binary outcome which can be modeled by a standard probit model. The second question is the volume of investment which is left-censored at zero. To address this, two-part and Heckman selection models are employed. More formally, the models are stated below.

A firm invests in self-generation if the NPV of the investment is positive. However, we observe whether the firm has invested in self-generation or not. Assuming unobserved latent variable y^* that establishes the following linear relationship between the relevant variables.

$y^* = \alpha x_i + u_i$ (2)

where x_i is a vector of explanatory variables, α is the associated parameters to be estimated, u_i is a normally distributed error term with mean zero and variance σ_{ui}^2. The observed variable y, is related to the latent variable y^* as follows:

$$y = \begin{cases} 1 \text{ if } & y* > 0 \\ 0 \text{ if } & y* \leq 0 \end{cases} \tag{3}$$

Determinants of a firm's incentive to invest in self-generation are estimated by probit model as indicated above. In the second part, linear regression model is used only for estimating a positive value. Thus, the two-part model for y_i following the approach stated in Cameron and Trivedi (2005) is given by:

$$f(y/x) = \begin{cases} Pr(d = 0 \ / \ x), & if\ y = 0 \\ Pr(d = 1 \ / \ x) f(y \ / \ d = 1, \ x) & if\ y > 0 \end{cases} \tag{4}$$

Where y denotes the volume of investment, d is a binary indicator such that $d = 1$ if $y > 0$ and $d = 0$ if $y = 0$. When $y = 0$ we observe only $Pr(d = 0)$. For those with $y > 0$, let $f(y / d = 1)$ be the conditional density of y.

The above model can be translated into the following empirical model.

$$Pr(d = 1 \ / \ x) = \alpha_0 lnHi + \alpha_1 constraint + \alpha_2' X_i + \mu_j + \eta_n + \varepsilon_1 \tag{5a}$$

$$y = \beta_0 lnHi + \beta_1 constraint + \beta_2' X_i + \vartheta_j + \theta_n + \varepsilon 2 \tag{5b}$$

where X_i = [ownership_i, exporter_i , Age_i, managerial exprience_i, *firm* size_i], H_i is the total duration of a power outage a firm i face in a year, *constraint* is the alternative definitions of credit constraints discussed above, μ_j and ϑ_j captures j industry dummies in the two equations, η_n and θ_n captures n country dummies, ϵ_1 and ϵ_2 are a normally distributed error terms with mean zero and variance of $\delta_{\epsilon 1}^2$ and $\delta_{\epsilon 2}^2$ respectively. Equation (5a) is a binary outcome equation and estimated by a probit model while equation (5b) is a linear equation only for firms that have positive investment.

The two-part model has some flexibility and computational simplicity by assuming that the two parts– the decision to invest and the volume of investment– are independent. But firms with positive investments are not randomly selected from the population. This may result in second stage regression to suffer from selection bias (Cameron and Trivedi (2005). To allow for the possible dependency between the equations, the selection model of Heckman (1979) is also used.

The main interest in equations (5a) and (5b) is to identify the causal effect of credit constraints on investment decisions. However, there is a potential reverse causality in the model because firms with poor investment opportunities are more likely to be credit constrained. Following the approach in (Petersen and Rajan, 1994 and Garcia-Posada, M. 2018), we implemented different strategies to tackle this identification challenge. First, traditional determinants of firm investment opportunities such as firm size and firm age are included as control variables. Second, country and industry dummies are included to control for the country and industry specific investment opportunities. Third, the perceived financial obstacles, rather than actual financing constraints are used as an alternative definition of credit constraint as a robustness check for the result obtained.

However, including these variables may not perfectly control for a firm's investment opportunities. Thus, as a final strategy to tackle the potential reverse causality in the model, the study uses an instrumental variable to isolate the exogenous part of credit constraints. Following the logic of Beck and Demirguc-Kunt (2006) and Fowowe (2017), banking regulatory and supervisory structure are used as IV for the credit constraint variable in this study . Specifically, the average tenure of bank supervisors and an index of overall supervisory independence from both banks and politicians are used as an instrument for credit constraint. It is expected that bank regulation and supervision will influence a firm's access to finance but do not have a direct impact on firm performance.

3. Results

4.1. Credit Constraint and Investment in Self-generation

The effect of credit constraint and a power outage on a firm's investment decision is reported in Table 4. The Table summarizes the results estimated by the two-part model and the Heckman selection model. In both specifications, the decision to invest is estimated by the probit model. The coefficient estimates of the two-part model are reported in the first column of Table 4. As can be seen from the Table, the sign and significance of coefficient estimates are the same across the two models except for age, which is positive and significant in the two part model while it is negative and insignificant in the Heckman selection model. Although the two-part model is flexible and attractive because it allows different covariates to have a different impact on the two parts of the model, it may result in a potential restriction due to non-random selection of firms with positive investment. The Heckman selection model, on the other hand, considers the possibility of dependence between the two parts of the model: the decision to invest and the volume of investment.

The coefficient of ρ, which measures a correlation between the error terms in the two equations, is significant. Furthermore, the likelihood ratio test also rejects the hypothesis that the correlation between the error terms in the selection and outcome equations are not significantly different from zero. This shows that the two equations are not independent and there is evidence of sample selection. The discussion of the result is thus, based on the Heckman selection model and the two-part model is presented here as a robustness check to the result obtained.

In the Heckman selection model, there should be at least one variable in the selection equation which is not included in the outcome equation for a robust identification. In this study, a set of industry dummies are included only in the selection equation. The assumed hypothesis is that industry dummies affect the decision to invest in self-generation but not the volume of investment. This is mainly due to the fact that some industries need a continuous supply of electricity in which they are more willing to invest in self-generation than in other industries.

The coefficient of outage time is positive and significant both in the selection and outcome equations. This shows higher outage time increases a firm's propensity to invest in self-generation and the volume of investment. The theoretical model used in this study shows that the effect of outage time on a firm's decision to invest in self-generation depends on the firm's degree of vulnerability to a power outage and the expected productivity of the installed generator. If the expected return from investing in self-generation is less than the firm's vulnerability to a power outage (outage loss), the firm has no incentive to invest in self-generation and vice-versa. The result obtained shows that the coefficient of outage time is positive and significant indicating that the return to a firm from the investment outweighs the cost of doing so.

The variable $constraint_a$ is negative both in selection and outcome equations. However, it is significant only in the selection equation. The result obtained suggests that credit constraints affect a firm's decision to invest in self-generation negatively. This indicates that a firm that is credit constrained is less likely to invest in self-generation compared to firms that are not credit constrained. Even though it is not significant in the outcome equations, a sign of the variable is maintained indicating that being credit constrained discourages a firm's investment in self-generation. This is in line with the theoretical prediction in which firms that are credit constrained are those that do not have easy access to external finance. This, on the other hand, increases firms' borrowing costs and worsens firms' Net Present Value (NPV) which eventually discourages firms' incentive to invest.

The coefficients of size dummies are significant, and it is positive for large firms. This indicates that large firms are more likely to invest in self-generation compared to medium firms (base category) while small firms are less likely to invest in self-generation compared to medium firms. This could reflect firms' ability to finance investment in self-generation. Larger firms are more likely to have access to external funds to finance their operations, including self-generation, and hence less credit constrained. This adds to the result obtained in descriptive statistics reported in Table 2 and the findings of (Abdisa, 2018 and Steinbuks, 2010).

Table 4
Credit constraint and Investment in self-generation

Variable	two-part model (1)		Heckman selection model (2)	
	Probit	$G_{sh} > 0$	Probit	$G_{sh} > 0$
Outages(*ln*)	0.024*	0.011***	0.038***	0.010***
	(0.016)	(0.002)	(0.016)	(0.002)
A*ge*(*ln*)	0.112***	-0.001	0.094	-0.004
	(0.035)	(0.005)	(0.035)	(0.005)
$Constraint_a$	-0.141***	-0.008)	-0.138***	-0.0037
	(0.051)	(0.006)	(0.051)	(0.006)
Small	-0.463***	-0.0037	-0.451***	0.006
	(0.055)	(0.0075)	(0.056)	(0.008)
Large	0.4038***	0.018**	0.394***	0.006**
	(0.080)	(0.009)	(0.080)	(0.010)
Industry dummy	Yes	Yes	Yes	No
Country dummy	Yes	Yes	Yes	Yes
ρ			-0.492***	
			(0.093)	
δ			0.155***	
			(0.003)	
LR test of indep. eqns ($\rho = 0$)			$\chi^2(1) = 9.98$ $P > \chi^2 = 0.001$	

Column one reports the result estimated by the Heckman selection model. The figures in brackets are standard errors. Probit is the decision equation which indicates whether a firm has invested in self-generation or not and $G_{sh}$is the volume of investment for those who have invested in self-generation. $G_{sh}$is measured by the percentage of self-generation from the total electricity load of the firm. The variable credit $constraint_a$ is a dummy variable which measures a firm's credit constraint and takes a value of 1 if the firm is credit constrained, zero otherwise. The base category for firm size is medium.

3.2. Robustness checks

To test the robustness of the result obtained, alternative definitions of credit constraint are used, and the result is reported in Table 5 and Table 6. In Table 5, the credit application information is used to classify firms as credit constrained or credit unconstrained. The coefficient estimate of credit constraint is

negative and significant in the Heckman model while it is negative but insignificant in the two-part model. In Table 6, a categorical variable generated from the firm's response to the question 'do credit constraint is an obstacle to the operation of your establishment' is utilized. The result indicates that firms that perceived lack of access to finance as a major constraint to their operation are less likely to invest in a self-generation compared to firms that perceived lack of access to finance is only a minor obstacle to their operation. In all specifications, a lack of access to finance is found to affect a firm's investment decision, not the amount of investment to be made.

Needless to say, results from alternative regressions show that credit constraint affects a firm's decision to invest in self-generation. In particular, credit constraint affects a firm's decision to invest but not the volume of investment. The result is insensitive to the alternative definitions of credit-constrained used indicating the robustness of the result obtained.

Table 5
Credit constraint and self-generation

Variable	Heckman selection model		Two-part model	
	Probit	$G_{sh} > 0$	Probit	$G_{sh} > 0$
Outages(*ln*)	0.029*	0.011***	0.016	0.011***
	(0.018)	(0.002)	(0.018)	(0.002)
Age(*ln*)	0.095***	-0.002	0.110***	0.002)
	(0.038)	(0.005)	(0.038)	(0.005
$Constrain_1$	-0.094*	-0.003	-0.075	-0.003
	(0.054)	(0.007)	(0.054)	(0.007)
Small	-0.446***	0.007	-0.474***	-0.006
	(0.061)	(0.008)	(0.068)	(0.007)
Large	0.407***	0.0003	0.415***	0.012
	(0.090)	(0.0.011)	(0.090)	(0.010)
Industry dummy	Yes	No	Yes	Yes
Country dummy	Yes	Yes	Yes	Yes
ρ	-0.477***			
	(0.081)			
δ	0.151**			
	(0.003)			
LR test of indep. eqns ($\rho = 0$) $\chi^2(1) = 7.2$ $P > \chi^2 = 0.007$				

Figures in bracket are standard errors. $Constrained_1$ is the credit application approach to credit constraint. Compared to the result reported in Table 3, the same estimation strategy is followed except the alternative definition of credit constraint is used.

Table 6
Credit constraint and self-generation

Variable	Heckman selection model		Two-part model	
	Probit	$G_{sh} > 0$	Probit	$G_{sh} > 0$
Outages(*ln*)	0.038**	0.013***	0.024*	0.011***
	(0.016)	(0.003)	(0.016)	(0.002)
Age(*ln*)	0.092***	-0.003	0.111**	-0.001
	(0.036)	(0.007)	(0.004)	(0.005)
Credit constraint				
Moderate	-0.073	-0.007	-0.0743	-0.001
	(0.064)	(0.012)	(0.064)	(0.007)
Major	-0.195***	-0.032***	-0.199***	-0.0218
	(0.057)	(0.012)	(0.057)	(0.008)
Small	-0.443***	0.017	-0.461***	-0.005
	(0.056)	(0.011)	(0.056)	(0.007)
Large	0.0393***	0.010	0.405***	0.018**
	(0.080)	(0.014)	(0.080)	(0.009)
Industry dummy	Yes	No	Yes	Yes
Country dummy	Yes	Yes	Yes	Yes
ρ	-0.524***			
	(0.061)			
δ	0.222***			
	(0.005)			
LR test of indep. eqns ($\rho = 0$)$\chi^2(1) = 14.63$ $P > \chi^2 = 0.000$				

The variable credit constraint is the firm's response to a question that "does lack of access to finance is an obstacle to operation of your establishment?". The response is classified as minor, moderate, and major obstacle. The minor obstacle is the base category in the estimation

3.3. Instrument variable

So far, the identification strategy has relied on the extensive use of country-industry dummies and firm-level covariates to control for firms' investment opportunities. In addition, the alternative definitions of

credit constraints are used and the result obtained indicates that firms that are credit constrained are less likely to make an investment in self-generation compared to firms that are credit unconstrained under all specifications. However, if investment opportunities are not perfectly controlled, then the error term will be correlated with the credit constraint variable which leads to potential reverse-causality bias. Hence, in robustness, an instrumental variable is used to tackle the potential reverse causality bias in the model.

The result of an instrumental variable estimation is reported in Table 7. In the first stage, the credit constraint variable is regressed on a set of firm control variables, industry dummies, and the instruments. This is estimated by a linear probability model. The first stage statistics are reported in the last rows of the Table and indicate that the instruments are strong predictors of firm credit constraint. The credit constraint variable in equations 5a and 5b are replaced by the predicted residual (ivresid) from the first stage regression. Replacing credit constraint by the predicted residual from the first stage regression, the model in equations 5a and 5b are estimated by the Heckman and the two-part models.

The result is in line with the results obtained previously and confirms the previous findings that firms that have difficulty in obtaining credit access are less likely to invest in self-generation compared to firms that are credit-unconstrained. Like the result obtained earlier, the credit constraint variable negatively affects a firm's decision to invest in self-generation in both Heckman and two-part model.

Table 7
Instrumental variable Estimation

Variable	Heckman selection model		Two-part model	
	Probit	$G_{sh} > 0$	Probit	$G_{sh} > 0$
Outages(*ln*)	0.038***	0.010***	0.024	0.011***
	(0.016)	(0.002)	(0.016)	(0.002)
Age(*ln*)	0.093***	-0.004	0.111***	-0.001
	(0.038)	(0.005)	(0.035)	(0.005)
ivresid	-0.134***	-0.005	-0.137***	-0.009
	(0.051)	(0.006)	(0.051)	(0.006)
Small	-0.460***	0.011	-0.473***	-0.004
	(0.056)	(0.008)	(0.055)	(0.007)
Large	0.4077***	0.007	0.416***	0.019**
	(0.080)	(0.010)	(0.080)	(0.009)
Industry dummy	Yes	No	Yes	Yes
Country dummy	No	No	No	No
First stage F-stat.	11.70			
P-Value	0.002			
LR test of indep. eqns ($\rho = 0$) $\chi^2(1) = 10.39$ $P > \chi^2 = 0.001$				

Note: ivresid is the predicted residual from the first stage regression of credit constraint on firm controls, industry dummy and instruments. Since the instruments vary only across countries, including these instruments and country dummies result in perfect collinearity. The figures in brackets are standard errors.

4. Conclusion And Policy Implications

The study examined the impact of credit constraint and power outages on the firm's investment decision using WBES data collected from firms operating in 13 SSA countries. The study employed a two-part model and Heckman selection model to estimate the impact of lack of access to finance and poor power supply on a firm's decision to invest in self-generation.

The result obtained suggest that there is a negative correlation between credit constraint and a firm's decision to invest in self-generation. This indicates that firms that are credit constrained have less incentive to invest in self-generation compared to those that are not credit constrained. The effect of outage time is found to be positive under all alternative specifications indicating that a poor supply of

electricity induces firms to invest in self-generation. However, firms are constrained by a lack of access to finance to fully backup their electricity load. This implies that firms that invested in self-generation continuous face outage loss.

To test the robustness of the result obtained, alternative definitions of credit constraints were used. Results from alternative regressions using different definitions of credit constraints show that credit constraint affects a firm's decision to invest in self-generation. In particular, credit constraint affects a firm's decision to invest but not the volume of investment. This shows the result obtained is insensitive to the alternative definitions of credit-constrained used indicating the robustness of the result obtained. To control potential reverse causality bias that arises from a two-way causality between investment opportunities and credit constraints, the study implemented different strategies. These include controlling for traditional determinants of firm investment opportunities such as age and firm size. Furthermore, country and industry dummies were included to control for country and industry specific investment opportunities and the perceived financial obstacles, rather than actual financing constraints are used as an alternative definition of credit constraint as a robustness check for the result obtained. As a final strategy to tackle the potential reverse causality in the model, the study used an instrumental variable to isolate the exogenous part of the credit constraints. The results from alternative specification and IV estimation is in line with the results obtained from the two-part and Heckman selection models confirming the findings that firms that have difficulty in obtaining credit access are less likely to invest in self-generation compared to firms that are credit unconstrained.

The result of the study implies that for firms to improve their performance, they should overcome the credit constraints. This, however, poses an important challenge for the governments of the SSA countries. That means, governments and financial institutions in African countries should make concrete efforts needed to be undertaken to overcome constraints in obtaining finance and boost access to financial services for firms. This is mainly important for SSA countries as firms are assumed to play a key role in economic growth, employment creation and hence poverty reduction. Thus, in order to solve the problem, it is quite important to approach the problem from both demand and supply side dimensions. On the demand side, the interaction of firms and financial institutions should be improved. For example, the data used in this study shows that about 42% of firms reported that they did not apply for loan, but are financially constrained, because of complex financial procedure in getting the loan such as high/unfavorable interest rate, collateral requirements and small loan size offered by these financial institutions. Thus, the government should work with the financial institutions to ease firms' financial constraints. On the supply side, the government and firms should work closely to figure out the nature of financial systems in SSA countries and how demand could meet given the supply. In this regard, the survey data used in this study shows that about 2% of firms that are financially constrained due to the amount loan of offered to them is less than the amount demanded by firms.

Declarations

Compliance with Ethical Standards

Data Availability Statement

Data used in this manuscript will be available up on request.

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31. Appendices.

Appendix

Appendix Table 1: Access to finance as obstacle to doing business

To what degree access to finance is obstacle to the current operation of this firm?	Frequency	Percentage	Category
No obstacle	620	17.37	unconstrained
Minor Obstacle	831	23.28	unconstrained
Moderate obstacle	760	22.13	constrained
Major obstacle	852	23.87	constrained
Very severe obstacle	477	13.36	constrained

The column category shows whether the firm is credit constrained or not based on the perception approach to definition of credit constraint given in section 2.2

Appendix Table 2: Loan application and reasons for not applying

Did this company applied for credits or loan?						
Yes	687 (19.83%)					
	Outcome of application					
	approved		rejected		in process	
	408		4		21	
	(94.22)		(0.92)		(4.85)	
Category	unconstrained		constrained		NC	
No	2778(80.17)					
	Reason for not applying					
	no need	complex pro.	interest unfav.	coll. requ.	loan size	others
	1248	290	475	343	55	289
	(46.39)	(10.78)	(17.66)	(12.75)	(2.04)	(10.38)
Category	Unconstrained	Constrained	Constrained	Constrained	Constrained	Constrained

Figures in brackets are percentages. Categories are based on the definition given in section 2.2, the credit application information approach. Firms that have applied but their application is still in process during the survey are not considered (NC).