Original Article

Electricity Access and the Performance of Micro and Small Enterprises: Evidence from West Africa

Michael Grimm[a,b,c], Renate Hartwig[a,b] and Jann Lay[d,e]

[a]University of Passau, Passau, Germany.
[b]Erasmus University Rotterdam, Rotterdam, The Netherlands.
[c]IZA, Bonn, Germany.
[d]German Institute of Global and Area Studies (GIGA), Hamburg, Germany.
[e]University of Göttingen, Göttingen, Germany.

Abstract Although it is widely accepted that electricity access is important for enterprise performance, the empirical evidence on the subject is mixed. In addition, evidence is scarce for micro and small enterprises operating in the informal sector. On the basis of a representative sample of informal firms in seven West African cities, we do not find evidence of a systematic, significant contribution of electricity access to enterprise performance. However, concentrating on a more homogeneous sample of tailors in Ouagadougou, we find that electricity can potentially exert a positive influence on performance, with electricity contributing to the uptake of modern machinery and business operation. Our findings are another illustration of the heterogeneity of the informal sector, which needs to be taken into account when policy interventions intend to overcome the growth constraints of firms operating in this segment of the economy.

S'il est largement reconnu que l'accès à l'électricité joue un rôle important dans la performance des entreprises, les données empiriques sur la question sont mitigées. Qui plus est, peu d'informations sont disponibles concernant les petites et micro-entreprises opérant dans le secteur informel. Nous constatons, à partir d'un échantillon représentatif d'entreprises informelles de sept villes d'Afrique occidentale, qu'il n'existe aucune donnée démontrant un effet positif systématique et significatif de l'accès à l'électricité sur la performance des entreprises. Cependant, en examinant de près un échantillon plus homogène de tailleurs travaillant à Ouagadougou, nous observons un effet positif de l'électricité, l'accès à cette dernière favorisant l'adoption de machines modernes et contribuant au fonctionnement des entreprises. Nos résultats offrent une nouvelle illustration de l'hétérogénéité du secteur informel, qui doit être prise en compte lors de l'élaboration de politiques publiques destinées à aider les entreprises opérant dans ce segment de l'économie à surmonter les obstacles à la croissance.

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Introduction

The lack of adequate infrastructure is widely perceived as a deterrent to business development and growth in many low-income countries. With a renewed interest in the promotion of the productive sector, many low-income countries – sometimes supported by development cooperation – are (again) increasingly investing in large-scale infrastructure projects with the objective to attract private sector investment and spur enterprise development. The empirical evidence that is presented in support of this policy is mainly based on either cross-country growth regressions or on country-specific studies that typically focus on the rural agricultural sector or larger, mainly

formal, firms in the manufacturing sector.[1] Much less is known about the relevance of infrastructure services, such as energy or telecommunication, for the performance of micro and small enterprises (MSEs) in the informal sector. So far, the debate on the barriers to growth in this sector largely focused on either capital market constraints and the role of micro-credit or the lack of skills and entrepreneurial talent (for example, De Mel *et al*, 2008; Karlan and Valdivia, 2011). In this article, we address this gap in the empirical literature by investigating the importance of access to electricity for the performance of MSEs in the urban informal sector.

The empirical analysis presented in this article is based on a very detailed, albeit cross-sectional, micro data set of informal enterprises in seven West African capital cities collected in 2001/2002 (hereafter referred to as '1–2–3 surveys'). In order to deepen the analysis, we also use panel data from a more recent survey conducted among tailors in Ouagadougou, in January 2011 and 2012 (hereafter referred to as 'tailor survey'). In both surveys, an informal enterprise is defined as one that is not registered with the tax administration, irrespective of its size.

On the basis of the 1–2–3 survey data, we do not find a systematic, significant influence of access to electricity on enterprise performance, which we attribute to the high degree of heterogeneity of the informal enterprises in our sample. In contrast, for the more homogeneous sample of informal tailors in Ouagadougou, we find a positive influence of access to electricity on MSE performance by promoting the uptake of modern machinery and business operation.

The remainder of our article is structured as follows. The next section provides a brief overview of the discussion in the literature and the empirical evidence so far. The subsequent section and the section after that present the data and empirical strategy. The results are discussed in the penultimate section. The final section concludes.

Literature Review

Although it is generally accepted that the supply of and access to electricity is an important factor for enterprise performance, there is still much debate on how important it actually is and whether electricity can be considered a necessary or sufficient condition for enterprise development and success. On the basis of an extensive literature review on manufacturing enterprises in developing countries, Tybout (2000), for example, concludes that electricity is one of the decisive components of enterprise success. In addition, several studies using perception-based data where owners are directly asked about their major constraints to firm growth convey the importance of electricity (see, for example, Ingram *et al*, 2007; Goedhuys and Sleuwaegen, 2010).[2] These studies, as well as that by Tybout (2000), typically rely on data from medium to large formal sector manufacturing enterprises. Recent studies often also use the World Bank Enterprise Surveys. Although some of these surveys cover both formal and informal firms, they sample only firms that are operating from a professional business locality with a minimum staff. This means that a major share of informal sector firms are not included as many are operated only by the owner often in a mobile manner or from market stalls.

MSEs are distinct from medium to large firms not only with regard to size. They operate in different markets (often catering the consumer directly) and are often more financially constrained. Similarly, the positive effect of electricity found in the above studies for bigger firms might not apply to MSEs.

A limited number of studies have analysed whether this is the case. Little (1987), for example, highlights the importance of electricity access as a basic ingredient for MSE performance in developing countries. Fakira (1994) also considers electricity to be a crucial factor to liberate micro enterprises from low value, low productivity and low-income activities. However, in-depth

quantitative studies on mainly informal MSEs suggest that the role of electricity for firm growth may be limited. For urban small firms in Northern Myanmar, Bah and Cooper (2012), for example, find that, although the quality, cost and access to electricity is reported as major constraint to business growth, it is actually the lack of credit paired with an aversion to debt that limits enterprise growth and prevents the entrepreneurs from taking advantage of the prevailing high returns on investment. Taken together, there is little research on the electricity-performance nexus for MSEs in the urban informal sector, whereas some studies are conducted in rural settings. The latter typically find that electricity is just one of many inputs necessary to promote enterprise growth (see, for example, Barnes, 1988). Rogerson (1997), studying MSEs in rural South Africa, concludes that access to electricity encourages the modernization of MSEs but only exerts a modest stimulus on revenue growth due to a myriad of constraints that these micro enterprises are confronted with, including further infrastructure limitations (for example, market access). In Kenya, Kirubi (2006) shows that the productivity per worker and gross revenue per day increase by around 200 per cent for both carpentry and tailoring micro enterprises following the introduction of a rural electrification and extension project. Yet, his findings indicate that access to electricity contributes to robust growth of micro enterprises only in combination with other infrastructure services and access to markets. Motta and Reiche (2001) also emphasize the importance of complementary services like telecommunication and transport in conjunction with electrification for the development of small firms in off-grid areas in Nicaragua. Evidence from rural Southern Uganda, provided by Neelsen and Peters (2011), suggests that electrification alters the sectoral composition of economic activities. On the basis of firm-level data from 200 micro enterprises, they do not find a significant effect of electrification on firm profits or worker remuneration. Qualitative evidence from the same study, however, points to a positive indirect effect of electrification by increasing local demand as people move to the area. Peters *et al* (2011) provide similar evidence in rural Benin. Electrification seems to have a positive effect on firm creation, but already existing micro manufacturers do not perform better following the connection to the grid. In earlier work on rural Benin, Peters *et al* (2009) point out that users of electricity are often not aware of its economic potential. Although firms in rural Benin, which are connected to the electricity network, work longer hours, only a few of those that could potentially use modern machinery do have electricity access. In addition, among the firms connected to the grid not a single one uses machinery (yet). One explanation put forward by Peters *et al* (2009) are credit constraints. Hence, credit would be needed to unlock the potential gains of access to electricity. Kooijman-van Dijk (2012), who studies the mechanisms between energy supply and income generation using data from 264 small and mostly informal firms in the Indian Himalayas, also finds little impact of electricity on income. She shows that even where access to electricity does promote the uptake of electric appliances such as lightening or electric sewing machines, the lack of a market for the goods and services produced constrains firm growth.

In contrast to the findings by Neelsen and Petersen (2011) and Kooijman-van Dijk (2012), Khan (2001) highlights the positive influence of better lighting on income generation due to extended business hours in the evenings. For tailors in Bangladesh, access to electricity and thus lightening led to an on average 30 per cent higher turnover (Kahn, 2001).[3] Similarly, repair shops in Bangladesh with access to electricity have reportedly seen an increase in daily earnings (Meadows *et al*, 2003).

Although access to electricity is generally perceived as beneficial to enterprise performance, it is obvious from the review above that at least in rural contexts and for micro and small firms the empirical evidence on the subject is rather mixed. This may be partly explained by the costs of electricity that can be very high. Gitonga (1999), for example, shows that in Nairobi, small and medium informal enterprises tend to spend quite high amounts on energy services, with

20 per cent of the owners reporting to spend up to 50 per cent of their revenue on energy; another 40 per cent use 10–20 per cent of their revenue.

Not only is the evidence mixed, but most of the studies cited above are mainly exploratory. Exceptions are the studies by Peters *et al* (2009) and Neelsen and Peters (2011). In addition, there is little empirical work concerned with the role of electricity for the performance of informal MSEs in urban settings. The studies on rural firms highlight that there are a number of other factors that can prevent the perceived positive effect of access to modern energy from materializing. These factors include a lack of knowledge on the potential benefits of modern energy use, a lack of financial resources required to invest in modern machinery or simply a lack of market and demand for the goods and services produced. Although these findings are from rural settings, similar mechanisms may be at work for MSEs in the urban informal sector. Urban MSEs are likely to be credit constrained as well. Whether the lack of knowledge and market access and size are as important as in rural areas is, however, difficult to say.

The Data

The analysis in this article draws on two distinct data sources. First, we use cross-sectional data from the 1–2–3 surveys conducted in the capital cities of Benin, Burkina Faso, Côte d'Ivoire (CDI), Mali, Niger, Senegal and Togo between 2001 and 2002. This survey was specially designed to study the informal sector and, as suggested by its name, was conducted in three stages comprising a labour force survey (Stage 1), an enterprise survey (Stage 2), which we use in this article, and a household expenditure survey (Stage 3).[4] The main advantage of the 1–2–3 survey is that it is not discretionary on firm size and not limited to firms operating from fixed locations and hence includes enterprises that are operated from home or are fully mobile, thus providing a more complete image of the informal sector. Our analysis, however, concentrates on enterprises that are operated from a permanent business locality only, that is, from home, a market stall, shop, office, studio, workshop, garage, restaurant and so on. Our sample thus covers 1260 observations. The basic characteristics of the firms in this sample are presented separately for firms with and without access to electricity in Table A1 in the Appendix. Just above half (55.7 per cent) of the firms have access to electricity with the highest access rates found in Benin, Côte d'Ivoire and Senegal. Considering the sectoral composition, firms, which report to have electricity access, are mainly engaged in the clothing and apparel, (other) manufacturing and whole/retail sectors. In line with expectations, fewer firms in construction, transport or petty trade have access. Considering the characteristics of the enterprise owners, over 70 per cent of the owners in our sample are male. This compares to about 50 per cent when mobile businesses are taken into account as well. This may be due to the flexibility needed to comply with family obligations and even more difficulties to access capital than men. Among the firms with fixed locations, the ones operated by women are less likely to have access to electricity. In addition to the gender disparity, the descriptive statistics also show a clear disparity in the education and wealth of owners with electricity access compared with those without. Although firms with and without access have been in operation for similar time periods (about 8 years), businesses with access to electricity perform on average better judged by the number of staff, capital and the value added generated. This may suggest that electricity access exerts a positive influence on enterprise performance and growth.

Additional data on a more homogeneous sample of informal entrepreneurs, namely, tailors operating in Ouagadougou, the capital city of Burkina Faso, allows for deeper analysis. This second data source is based on a more recent survey that we undertook in collaboration with

a local survey firm in January 2011 and 2012, respectively. Of the 239 informal tailors interviewed in 2011, 202 tailors were revisited in 2012, implying an attrition rate of 15 per cent.[5]

The basic characteristics of the informal tailors are presented in Table A2 in the Appendix. Similar to the above sample from the 1–2–3 survey, the tailor sample also predominantly consists of male owners. Male owners have also more often access to electricity. Electricity access of the tailors has greatly improved between 2001 and 2011, with now over 86 per cent reporting to have access to electricity (the averages access rate in the clothing sector in Burkina Faso according to the 1–2–3 survey in 2001/2002 was 28.6 per cent). Moreover, in 2011 63 per cent of the tailors report to own an electric sewing machine, a share that increases to 78 per cent by 2012.[6]

The tailor survey is based on an extended version of the Phase 2 questionnaire of the 1–2–3 survey to ensure that both data sources are comparable. This means that key variables used for analysis are measured in exactly the same way. The access to electricity is based on the simple question whether the entrepreneur does have electricity at his/her business establishment or not (*Dans votre établissement ou emplacement disposez-vous de l'électricité*). Hence, the access to electricity figures in our analysis only as binary variable and we are not able to differentiate between various types of access (for example, official or unofficial, grid or generator). The capital stock is measured by the replacement value of all business-related assets, including properties, machines, furniture, vehicles and tools. Labour input is measured as the total number of hours worked in the enterprise in the past month. An alternative measure for labour input is simply the total number of staff. In case of the 1–2–3 survey, we measure firm performance on the basis of the monthly value added generated. This is calculated as sales minus input costs (for raw materials, intermediates and products for re-sale, taxes, rents and utility costs). However, in the case of the tailor survey, we prefer to work with the average monthly profit reported. In fact, we tried to collect very accurate, detailed information on all inputs used, but it turned out that the more detailed level of information collected, the higher its total sum, which in the end led to unrealistic estimates of value added.[7] Hence, we follow the recommendation by De Mel *et al* (2009) and use directly elicited income instead of adding up sub-categories. In the analysis of the tailor survey, we are also using a simple proxy for credit constraints. As in Grimm *et al* (2012), tailors are considered to have access to credit if any investment in the past was financed by family or external sources or if they have obtained a micro or bank credit in the past 12 months.

Empirical Strategy

The empirical analysis in this article is two-pronged. On the basis of the sample of informal firms from the 1–2–3 survey, we first aim to obtain a general indication on the potential role of electricity access for the performance of MSEs in an urban, informal setting. We then conduct a more in-depth analysis using the sample of tailors that also allows us to examine the potential transmission mechanisms between electricity access and enterprise performance.

We start from a basic Cobb–Douglas production function of the form:

$$Y_{ic} = A_{ic} K_{ic}^{\alpha} L_{ic}^{\beta} \tag{1}$$

where Y_{ic} represents the value-added of firm i in country c; A_{ic} is the total factor productivity (TFP); K_{ic} is the capital stock; and L_{ic} the labour efforts. If we assume that TFP depends on a firm level component, V_{ic}, and its immediate environment in terms of access to electricity, E_{ic}, then TFP can also be represented as:

$$A_{ic} = e^{E_{ic}} V_{ic} \tag{2}$$

Replacing A_{ic}, log-linearizing the production function and adding controls for firm-, country- and sector-specific characteristics (partly replacing $\ln(V_{ic})$), the basic estimation equation becomes:

$$\ln Y_{ic} = \alpha \ln K_{ic} + \beta \ln L_{ic} + \delta E_{ic} + X'_{ic}\gamma + p'\eta + s'\mu + v_{ic} \quad (3)$$

where X_{ic} represents a vector of firm-specific characteristics, including the age of the enterprise and the gender, age, education and wealth of the entrepreneur; p represents a vector of country dummies; and s a vector of sector dummies. As already outlined above, access to electricity, E_{ic}, is represented by a binary variable, and the coefficient of main interest is δ.

We estimate the above model using a standard OLS approach. We are aware that this exercise will only yield correlations, but with the data at hand, we are not able to address problems of unobserved heterogeneity and reverse causality. To account for the heterogeneity of activities in the informal sector, we also present results disaggregated by sector.[8]

We then estimate the same equation without country and sector dummies using the data from the tailor survey. As explained above, we proxy value added by reported average monthly profit. Furthermore, the panel dimension allows us to introduce firm fixed effects, that is, we can control for all time invariant unobserved factors and thus at least partly address endogeneity concerns.

Using only the tailor survey, we then proceed to examine two potential transmission channels between electricity access and firm performance. We first look at the relationship between access to electricity and the uptake of electric appliances. In the case of the tailors, we are particularly interested to determine whether access to electricity has affected the possession and use of modern machinery, that is, an electric sewing machine. Hence, we analyse the influence of electricity access, E^T_{jt}, using the following specification:

$$\Pr\left(M_{jt} = 1\right) = \theta\left(\sigma_{M0j} + \sigma_{M1}E^T_{jt} + C'_{jt}\sigma_{M2} + u_{Mjt}\right) \quad (4)$$

with M_{jt} being a binary variable indicating whether tailor j owns an electric sewing machine in time t. C_{jt} represents a vector of enterprise and owner characteristics including the capital endowment, number of staff, age of the enterprise, as well as, the gender, age, education and wealth of the owner. We estimate Equation (4) as basic probit model using only the 2011 cross-section and as a fixed effects model using the 2011 and 2012 panel data set.[9]

Second, we examine whether the access to electricity is also linked to longer working hours, possibly because of the availability of electric lightening. We test this using the following specification:

$$\ln L_{jt} = \sigma_{L0j} + \sigma_{L1}E^T_{jt} + C'_{jt}\sigma_{L2} + u_{Ljt} \quad (5)$$

where L_{jt} stands for the total labour hours worked. We estimate the equation using OLS and fixed effects. In this specification, we also control for the number of workers, ensuring that we focus on hours per worker.

Estimation Results and Discussion

Results Based on the 1–2–3 Surveys

The results of the multivariate regression approach outlined in the section 'Empirical Strategy' are presented in Table 1. Whereas the descriptive statistics suggested a positive relationship between the access to electricity and the performance of MSEs in the informal sector, the regression estimates depict a negative relation, meaning that electricity access actually exerts a negative influence on value added, with firms with access to electricity achieving on average

Table 1: Influence of access to electricity on value added (ln) (by sector)

	All	*Clothing*	*Manufacturing*	*Construction*	*Wholesale/retail*
Electricity (=1)	−0.096	0.444**	−0.393	−1.001	−0.297
	(0.094)	(0.212)	(0.255)	(1.255)	(0.239)
ln(K)	0.076***	0.220**	0.133**	0.114	−0.038
	(0.029)	(0.092)	(0.067)	(0.258)	(0.072)
ln(L)	0.468	0.396***	0.399**	0.299	0.571***
	(0.062)	(0.139)	(0.174)	(0.663)	(0.187)
Controls	Yes	Yes	Yes	Yes	Yes
R^2	0.255	0.320	0.206	0.771	0.207
N	1195	217	180	29	198

	Petty trade	*Hotel*	*Repair*	*Transport*	*Other*
Electricity (=1)	0.073	0.358	−0.198	−0.191	−0.208
	(0.276)	(0.442)	(0.235)	(1.348)	(0.329)
ln(K)	0.083	0.262*	0.076	0.098	0.074
	(0.063)	(0.148)	(0.083)	(0.292)	(0.068)
ln(L)	0.624***	0.140	0.545***	1.228***	0.536***
	(0.221)	(0.296)	(0.145)	(0.648)	(0.137)
Controls	Yes	Yes	Yes	Yes	Yes
R^2	0.297	0.317	0.348	0.847	0.356
N	193	91	135	24	128

Note: Robust, clustered standard errors in parentheses; * $P<0.10$; ** $P<0.05$; *** $P<0.01$.
Source: Authors' computations based on 1–2–3 survey, WAEMU, 2001.

a 9.6 per cent lower value added compared with firms without. If the results are disaggregated by economic sector, the negative influence is found to be driven by the manufacturing, construction, wholesale/retail, repair and transport sectors. In the clothing sector, however, electricity is found to exert a positive and statistically significant influence on value added, with firms with access to electricity actually achieving 44.4 per cent higher value added than firms without access to modern energy in their business establishment. The heterogeneity in the coefficients obtained leads to conclude that overall there is no systematic and uniform influence of electricity access on enterprise performance. One possible explanation for this finding could be the high degree of heterogeneity in the informal sector in general and in the sample in particular. A more disaggregated look at our sample supports this interpretation. The clothing and apparel sector appears rather homogeneous with respect to the activities undertaken. More than 85 per cent of the enterprises in this sector are engaged in the production of clothing, about 5 per cent in shoe production and another 5 per cent engaged in weaving. In contrast, activities in other sectors are much more heterogeneous. In the wholesale/retail sector, for example, activities include the operation of mixed retail stores (22 per cent), and a number of specialized stores selling and trading – in the order of importance – for example, food, beverages, clothing and vehicle parts. Obviously, the usefulness of electricity access is very likely to differ depending on the product of sale. This is even more likely to hold in micro manufacturing where we also observe quite some dispersion. Here, the most frequent activity is food production (20 per cent) followed by around 5 per cent of the enterprises engaged in wood work, and 70 other manufacturing activities with smaller shares. Additional support for heterogeneous impacts of electricity access comes from qualitative questions on the most eminent problems and the kind of support entrepreneurs would require for their business operation. Although a lack of credit and market access are frequently cited, it is only in the clothing and apparel and the repair sectors that more than two-thirds of the

entrepreneurs indicate that the lack of modern machinery and equipment poses a problem for their enterprise operation.

Results Based on the Tailor Survey

In light of the considerable heterogeneity of electricity impacts, for which we have presented suggestive evidence above – we now concentrate on the situation of one profession – tailors – in one location – Ouagadougou.

We first estimate Equation (3) to assess the influence of the access to electricity on enterprise performance measured by profit. The results are presented in Table 2. Although the results of the firm fixed effects regressions (Columns 3 and 4) return a positive coefficient for electricity access, the coefficient value is no longer statistically significant when further covariates controlling for firm characteristics are introduced.

As we suspect that the coefficient of interest may not be homogeneous across the profit distribution, we also ran quantile regressions. The results indicate that electricity access indeed exerts a significantly positive influence only at higher profit quantiles; hence, MSEs might have to pass a critical performance threshold for the positive effects of electricity access to kick in (see Table 3 for detailed results).

Further differences of the effect of electricity may be related to other constraints that the tailors face. Specifically, we test whether we can observe such differences when we distinguish between entrepreneurs with and without access to credit (Table 4). Looking at the 2011 data in isolation, access to electricity appears to have a positive significant influence only for firms that are not credit-constrained. This is in line with expectations, as access to credit is a prerequisite for the purchase of machinery. Although the coefficient remains positive, once unobserved time invariant factors are accounted for, the effect is no longer statistically significant.

We now examine the potential mechanisms linking electricity access to enterprise performance. We are starting by considering the link between electricity access and the uptake of modern machinery, in this case electric sewing machines. The estimation results are presented in Table 5. Concerning the use of modern equipment, the results clearly indicate that firms with access to electricity are indeed more likely to own more sophisticated electric machinery. The effect of electricity on the possession of at least one electric sewing machine is large, with firms

Table 2: Influence of electricity access on average profit (ln) (tailor sample)

	2011 sample		*2011 and 2012 panel*	
	OLS		*Firm fixed effects*	
	(1)	*(2)*	*(3)*	*(4)*
Electricity (=1)	0.387***	0.370**	0.209*	0.203
	(0.114)	(0.137)	(0.125)	(0.132)
ln(K)	0.065	0.021	0.103***	0.081**
	(0.087)	(0.085)	(0.037)	(0.037)
ln(L)	0.313**	0.256*	0.366***	0.318***
	(0.106)	(0.127)	(0.073)	(0.075)
Controls	No	Yes	No	Yes
R^2	0.104	0.180	—	—
N	225	225	422	422

Note: Robust, clustered standard errors in parentheses; * $P<0.10$; ** $P<0.05$; *** $P<0.01$.
Source: Own data, collected in January 2011 and 2012 in Ouagadougou, Burkina Faso.

Table 3: Influence of electricity access on average profit (ln) by quintile (tailor sample)

	2011 sample			
	Quantile regression			
	20	*40*	*60*	*80*
Electricity (=1)	0.120	0.239	0.373**	0.476*
	(0.176)	(0.156)	(0.185)	(0.256)
ln(K)	0.066	0.028	–0.010	0.060*
	(0.063)	(0.068)	(0.073)	(0.075)
ln(L)	0.022	0.276**	0.371***	0.475***
	(0.119)	(0.136)	(0.111)	(0.134)
Controls	Yes	Yes	Yes	Yes
R^2	0.103	0.121	0.117	0.130
N	225	225	225	225

Note: Robust, clustered standard errors in parentheses; * $P<0.10$; ** $P<0.05$; *** $P<0.01$.
Source: Own data, collected in January 2011 and 2012 in Ouagadougou, Burkina Faso.

Table 4: Influence of electricity access on average profit (ln) for credit-constrained and unconstrained tailors (tailor sample)

	2011 sample		*2011 and 2012 panel*	
	OLS		*Firm fixed effects*	
	Credit-constrained	*Unconstrained*	*Credit-constrained*	*Unconstrained*
Electricity (=1)	0.297	0.268*	0.238	0.116
	(0.242)	(0.136)	(0.196)	(0.158)
ln(K)	–0.007	0.049	0.014	0.087**
	(0.139)	(0.094)	(0.095)	(0.040)
ln(L)	0.069	0.249*	0.231*	0.314***
	(0.239)	(0.130)	(0.139)	(0.091)
Controls	Yes	Yes	Yes	Yes
R^2	0.248	0.193	—	—
N	59	166	94	328

Note: Robust, clustered standard errors in parentheses; * $P<0.10$; ** $P<0.05$; *** $P<0.01$.
Source: Own data, collected in January 2011 and 2012 in Ouagadougou, Burkina Faso.

with access to electricity being 29 per cent more likely to own an electric sewing machine. Conversely, having electricity access reduces the likelihood of employing mechanical sewing machines by at least 20 per cent (see Table A3 in the Appendix). Although it is impossible to separate cause and effect – even with firm fixed effects – the recovered correlation allows for the conclusion that electricity is an important component of the modernization of production, which in turn is likely to positively influence productivity.

In a second step, we test whether access to electricity is also associated with extended business and working hours due to better lighting. The estimation results are presented in Table 6 and show that access to electricity significantly increases working hours. The effect is very large, implying that tailors with access to electricity work around 13 per cent, or 3 labour hours more per day than firms without this access.

Table 5: Influence of electricity access on possession of electric sewing machine (tailor sample)

	2011 sample			*2011 and 2012 panel*		
	Probit (marginal effects reported)			*Firm fixed effects probit (marginal effects reported)*		
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Electricity (=1)	0.552***	0.397***	0.395***	0.367***	0.286***	0.287***
	(0.065)	(0.060)	(0.065)	(0.043)	(0.037)	(0.037)
Low capital		Ref.			Ref.	
Medium capital	—	1.095***	—	—	0.228	—
	—	(0.150)	—	—	(0.044)	—
High capital	—	1.406***	—	—	0.223***	—
	—	(0.145)	—	—	(0.045)	—
ln(K)	—	—	0.104***	—	—	0.104***
	—	—	(0.019)	—	—	(0.017)
Number of staff	—	0.052***	0.038	—	0.029**	0.027**
	—	(0.017)	(0.024)	—	(0.014)	(0.012)
Controls	No	Yes	Yes	No	Yes	Yes
Pseudo R^2	0.131	0.345	0.396	—	—	—
N	239	239	237	441	441	439

Note: Robust, clustered standard errors in parentheses; * $P<0.10$; ** $P<0.05$; *** $P<0.01$.
Source: Own data, collected in January 2011 and 2012 in Ouagadougou, Burkina Faso.

Table 6: Influence of electricity access on total labour hours (ln) (tailor sample)

	2011 sample			*2011 and 2012 panel*		
	OLS			*Firm fixed effects*		
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Electricity (=1)	0.525***	0.155	0.188*	0.292***	0.125**	0.132**
	(0.114)	(0.096)	(0.091)	(0.107)	(0.057)	(0.059)
Low capital		Ref.			Ref.	
Medium capital	—	–0.144	—	—	0.171***	—
	—	(0.092)	—	—	(0.038)	—
High capital	—	0.026	—	—	0.163***	—
	—	(0.047)	—	—	(0.036)	—
ln(K)	—	—	0.031**	—	—	0.045***
	—	—	(0.010)	—	—	(0.012)
Number of staff	—	0.276***	0.272***	—	0.270***	0.273***
	—	(0.026)	(0.026)	—	(0.021)	(0.022)
Controls	No	Yes	Yes	No	Yes	Yes
R^2	0.089	0.735	0.731	—	—	—
N	231	231	231	429	429	427

Note: Robust, clustered standard errors in parentheses; * $P<0.10$; ** $P<0.05$; *** $P<0.01$.
Source: Own data, collected in January 2011 and 2012 in Ouagadougou, Burkina Faso.

We concede that our empirical analysis has important limitations that are partly due to a lack of data. An important aspect that would merit further investigation is the quality and reliability of the electricity service. Fluctuations in voltage, for example, can cause severe

damage to the machinery, leading to high repair costs. Moreover, frequent power cuts may be associated with significant revenue losses. Informal sector entrepreneurs interviewed in the World Bank Enterprise Surveys in Burkina Faso in 2009 report an average monthly loss of sales of 5 per cent owing to power outages. Although firms may deal with fluctuations in power supplies by using generators, this does not seem to be common for informal firms in Burkina Faso. In the World Bank Enterprise Survey, less than 1 per cent of the interviewed informal enterprises own a generator. In our sample of tailors, 10 per cent have a generator, but only 3 per cent report that they are actually using it. Following work by Alby *et al* (2010), one reason for the low penetration of generators could be a lack of capital and the high cost of operating them.

Conclusion

Although electricity undoubtedly plays an important role for the modernization of production, and, hence, overall growth and development, the specific role for the performance of micro and small, and particularly informal, firms is less clear. The two main views in the literature see access to electricity either as a crucial independent factor for enterprise growth or as a necessary but not sufficient condition for success. The latter view implies that unless other inputs, such as credit, are also available, electricity does not have much effect on enterprise performance. This may hold particularly for urban informal MSEs, that is, firms that face a myriad of other constraints. This article addresses the lack of empirical studies on this particular group of firms and provides evidence on the effects of electricity on the performance of urban informal MSEs and on the transmission channels through which electricity access operates. Our analysis is based on micro data of informal firms in seven West African capitals collected in 2001/2002 and more recent data from a sample of tailors in Ouagadougou, which were interviewed in 2011 and 2012, respectively. We cannot conclude that access to electricity *per se* has a positive effect on performance. This would support the proposition that access to modern energy is a necessary but not a sufficient condition for enterprise success. This is related to the fact that many informal activities simply do not require electricity. In other cases, electricity could be useful in principle, but other constraints, in particular credit constraints, need to be tackled first (or simultaneously) to allow entrepreneurs to acquire more advanced technologies.

We show that the absence of a systematic effect of electricity for informal firms on average has to be considered in the light of the heterogeneity of the informal sector. Our analysis clearly demonstrates the need for a more detailed analysis of specific sectors, as our study of a randomly selected sample of tailors shows. For this group, electricity does seem to have an important positive effect on enterprise performance by allowing for longer working hours and enabling a higher penetration of modern equipment, such as electric sewing machines. The analysis also suggests that electricity access matters only once a critical firm size has been passed. Given the inclusion of firm fixed effects, these results are robust to time-constant unobserved heterogeneity.

In conclusion, improving access to electricity may make a significant contribution in some sectors and for some types of firms. Yet, it is certainly not a magic bullet for the informal sector as a whole. Hence, as is so often the case, a 'one-size-fits-all' approach is of little help. To be effective, the design of policies for the informal sector has to be carried out with a lot of care and requires rigorous evaluation and careful targeting. It is also evident that firms usually do not suffer from one single constraint but are typically confronted with a set of interdependent constraints that need to be addressed jointly.

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Notes

1. See Sanchez-Robles (1998) or Canning and Pedroni (1999) for examples of cross-country studies or Rijkers *et al* (2010) for a study on manufacturing firms in rural and urban Ethiopia. Lipscomb *et al* (2010) also provide an innovative study on the developmental effects of electrification in Brazil with some more discussion on the issue.
2. See Hausmann *et al* (2005) for a more detailed discussion on the issues arising from the use of perception-based data and more recently Clarke (2010) who is applying an experimental design to assess the quality of this data type.
3. The study further shows that in certain sectors, such as garment manufacturing, the availability of electricity determines the level of technology and has a strong influence on the cost and level of production.
4. For a detailed description of the data and sampling method, see Brilleau *et al* (2005).
5. Regressing a dummy for having been re-interviewed on the observed base year characteristics of these firms did not yield any systematic pattern.
6. The 78 per cent is based on the 2012 sample size of N=202.
7. It is not clear why this is not the case for the 1–2–3 surveys. A possible reason is that tailors are among those groups of entrepreneurs where there may be a considerable lag between input purchase and sale of the final product.
8. Further estimation results (by country) can be obtained from the authors upon request. We have also estimated the model presented in the section 'Empirical Strategy' with panel data from Peru allowing us to compare estimates with and without fixed effects. The results of this analysis do not change the basic notion of our arguments put forward here.
9. In addition, we run a reduced-form regression that links production, measured by the value of goods produced in the last 4 weeks preceding the survey, to the possession of modern machinery controlling for capital and labour input. Given that detailed production data was only collected in the 2011 round of the tailor survey, this reduced form can only be estimated using OLS leaving endogeneity a concern that cannot be sufficiently addressed. The regression returns a positive coefficient of electric machinery on production giving further comfort on the positive link as presented in the section 'Estimation Results and Discussion'. Detailed results can be obtained from the authors upon request.

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Appendix

Table A1: Description of the sample of informal firms operating from a permanent business locality (1–2–3 survey) split by electricity access

	Firms with access			*Firms without access*		
	N	*Mean*	*Standard deviation*	*N*	*Mean*	*Standard deviation*
Owner characteristics						
Male (=1)	702	0.747	0.435	558	0.586	0.493
Age (in years)	702	36.667	10.506	558	37.521	11.105
Years of education	702	5.413	4.603	558	3.288	3.803
Wealth quintile						
1	702	0.140	0.347	558	0.237	0.425
2	702	0.185	0.389	558	0.231	0.422
3	702	0.239	0.427	558	0.220	0.415
4	702	0.215	0.411	558	0.210	0.407
5	702	0.221	0.415	558	0.102	0.303
Firm characteristics						
Enterprise age (in years)	702	7.979	8.436	558	8.113	8.181
Total staff (including owner)	702	2.706	1.887	558	1.975	1.452
Capital (at replacement value, 2001 Fcfa)	702	1718.145	2044.899	558	828.245	1507.199
Value added (2001 Fcfa)	661	720.127	1708.003	534	505.374	1557.077
Sector composition						
Clothing and apparel	702	0.239	0.427	558	0.102	0.303
Other manufacturing	702	0.135	0.342	558	0.172	0.378
Construction	702	0.033	0.178	558	0.014	0.119
Wholesale/retail	702	0.168	0.374	558	0.172	0.378
Petty trade	702	0.068	0.252	558	0.272	0.446
Hotel/restaurant	702	0.078	0.269	558	0.068	0.252
Repair services	702	0.118	0.323	558	0.113	0.317
Transport	702	0.020	0.140	558	0.018	0.133
Other services	702	0.140	0.347	558	0.069	0.252
Country composition						
Benin	702	0.198	0.399	558	0.090	0.286
Burkina Faso	702	0.098	0.298	558	0.247	0.432
Côte d'Ivoire	702	0.272	0.445	558	0.167	0.373
Mali	702	0.078	0.269	558	0.137	0.343
Niger	702	0.052	0.224	558	0.059	0.236
Senegal	702	0.168	0.370	558	0.133	0.339
Togo	702	0.137	0.344	558	0.168	0.375

Source: Authors' computations based on 1–2–3 survey, WAEMU, 2001.

Table A2: Description of the tailor sample (tailor survey)

	2011			*2012*		
	N	*Mean*	*Standard deviation*	*N*	*Mean*	*Standard deviation*
Owner characteristics						
Male (=1)	239	0.799	0.401	202	0.797	0.403
Age (in years)	239	34.389	9.250	202	35.470	9.039
Education						
No education	239	0.213	0.411	202	0.228	0.420
Primary started	239	0.452	0.499	202	0.455	0.499
Primary completed	239	0.335	0.473	202	0.317	0.466
Secondary completed	239	0.113	0.317	202	0.109	0.312
Years managing the enterprise	239	7.017	6.465	202	8.243	6.616
Enterprise characteristics						
Enterprise age (in years)	239	7.197	6.593	202	8.361	6.669
Total capital (at replacement value, EUR)	239	653.541	1266.355	202	647.459	817.529
ln(capital)	237	5.661	1.436	202	5.995	0.969
Total staff (including owner)	239	3.649	1.804	202	3.406	1.763
ln(total hours worked per months)	231	6.600	0.592	198	6.694	0.641
ln(average profit per months, EUR)	235	8.799	0.927	201	9.019	0.957
Electricity access (=1)	239	0.866	0.341	202	0.872	0.384
Electric sewing machine (=1)	239	0.632	0.483	202	0.777	0.417
Mechanic sewing machine (=1)	239	0.762	0.427	202	0.688	0.464

Source: Own data, collected in January 2011 and 2012 in Ouagadougou, Burkina Faso.

Table A3: Influence of electricity access on possession of mechanic sewing machine (tailor sample)

	2011 sample			*2011 and 2012 panel*		
	Probit (marginal effects reported)			*Firm fixed effects probit (marginal effects reported)*		
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Electricity (=1)	–0.371***	–0.413***	–0.360***	–0.234***	–0.218***	–0.209***
	(0.067)	(0.117)	(0.071)	(0.062)	(0.063)	(0.061)
Low capital		Ref.			Ref.	
Medium capital	—	1.368***	—	—	0.083	—
		(0.133)			(0.055)	
High capital	—	1.579***	—	—	0.047	—
		(0.184)			(0.057)	
ln(K)	—	—	0.090***	—	—	0.053***
			(0.034)			(0.018)
Number of staff	—	–0.029**	–0.045***	—	–0.015	–0.024*
		(0.011)	(0.009)		(0.015)	(0.014)
Controls	No	Yes	Yes	No	Yes	Yes
Pseudo R^2	0.046	0.112	0.163	—	—	—
N	239	239	237	441	441	439

Note: Robust, clustered standard errors in parentheses; * $P<0.10$; ** $P<0.05$; *** $P<0.01$.
Source: Own data, collected in January 2011 and 2012 in Ouagadougou, Burkina Faso.