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Electricity and manufacturing firm profits in Myanmar

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Abstract

We examine the impact of being located in areas with higher availability of electricity on manufacturing firm profits in Myanmar. Using a survey of 497 manufacturing firms conducted in 2014 and covering the whole territory of Myanmar, we investigate whether firms belonging to industries that tend to make more intensive use of electricity show better performance if such firms are located in areas with higher availability of electricity. We find that electricity provided by the national power grid tends to have a positive impact on manufacturing firm profits. Results are robust to reducing the sample to firms that could not have chosen their location endogenously, as well as to the use of an instrumental variable.

Keywords: Myanmar, electricity, firm performance

JEL codes: H4, O13, O14, L60

1 Introduction

Electricity supply is generally assumed to be crucial for economic development and firm profitability. Access to electricity is commonly associated on the one hand with increased use of modern machinery and on the other hand with extended business hours due to better lighting. Deficient electricity networks, characterized by frequent power outages and unstable voltage, may induce high back-up costs to firms and even deter some types of investments (Straub, 2008). Power outages have also been shown to largely decrease firm productivity in developing countries (Dollar et al., 2006; Arnold et al., 2008; Fernandes, 2008). The present study examines how access to electricity influences manufacturing firm performance, focusing on Myanmar, where electrification rates are some of the lowest in the world. In Myanmar, electricity access remains a large constraint to development: electricity is ranked as one of the largest obstacles to business by two business surveys conducted recently in Myanmar (Myanmar OECD-UNESCAP Business Survey 2014 and World Bank Enterprise Survey 2014).

Evidence that access to electricity effectively impacts firm performance is not consensual though. Using cross-sectional data for seven Western African capital cities, Grimm et al. (2013) find no systematic influence of access to electricity on micro and small enterprises' performance, which they attribute to the large heterogeneity of the firms in their sample. When they concentrate on a sub-sample of tailors in Ouagadougou, they find a positive correlation of their performance with access to electricity. Using the case of an electrification project in Benin, Peters et al. (2011) do not find that electrification is significantly associated with higher firm profits: Beninese rural firms that existed before electrification perform no better than their matched counterparts from a non-electrified region. The authors argue that newly electrified firms might overestimate future demand and over invest in electric appliances, which could lead to a negative impact of electrification on firm profits. In the same vein, but in Uganda, Neelsen and Peters (2011) find no evidence for an expansionary effect of electrification on firm profits. Based on qualitative information, they describe an indirect expansionary effect of electricity through local demand, partly due to increased immigration into electrified areas. The three aforementioned articles all focus on small and micro-enterprises which may partly explain the heterogenous effect of electricity on performance and the key role played by realistic firm business plans.

Using panel data on manufacturing output aggregated at the district level in India, Rud (2012) exploits the uneven expansion of electricity network to identify the impact of electrification on industrial development. He instruments the expansion of the electricity network with the uneven availability of groundwater across states, as electric pump sets were used to provide cheap irrigation water. He finds that the uneven expansion of the electricity network explains between 10 and 15 percentage points of the difference in manufacturing output across Indian states. The positive effect electricity coming from the grid has on firm performance has sometimes been explained by efficiency gains and reduced reliance on diesel. Asaduzzaman et al. (2010) find that electricity consumption affects enterprise profits. While kerosene or diesel consumption have no impact on performance, electricity has a significant positive effect. Enterprises would therefore gain by switching from biomass and diesel to electricity as an energy source in production. Using Korea as a case study, Jung and Lee (2014) find that the energy-transformation from fossil fuel to electricity by electrification could cause a decrease in the short-term level of productivity (due to investment in new equipment and learning costs), but to an increase in the long-term rate of productivity growth of manufacturing firms.

The present study takes advantage of the geographic coverage of a recent survey conducted in Myanmar (OECD-UNESCAP Myanmar Business Survey 2014) which provides information for a sample of almost 500 firms from all manufacturing sub-sectors. No other precedent study has been able to work with such a large sample of Myanmar firms and to combine the geolocation of firms with geographic information on access to electricity. We examine whether electricity has an effect on firm profits. After geolocating firms, we use maps of the electricity grid network to infer whether firms are connected to the grid. Our measure of access to electricity - a dummy for the firm being based in an area within a 30 kilometers radius from a power substation - seems to be consistent with an indicator of electricity as being perceived as an obstacle to firm activity. Moreover, we test the robustness of our results to the use of an alternative measure of access to electricity: a ratio of night lights' intensity to population.

To assess the causal impact of electricity on household or firm outcomes, most studies have so far made use of geographic instrumental variables (land or river gradient, distance to hydropower plant). Our identification strategy will rely on three distinct approaches, which reflect the three main sources of endogeneity bias in our framework. The first source of endogeneity bias is caused by omitted variables. This bias is addressed using a specification similar to the one presented by Rajan and Zingales (1998). We introduce our measure of electricity in interaction with an indicator of sector intensity in electricity. This indicator of sector intensity in electricity is based on data for US manufacturing firms, hence being exogenous to the Myanmar context and reflecting firm needs in electricity in a regime close to perfect competition. This first strategy - introducing the measure of electricity at the coordinates level in interaction with the intensity in electricity at the sector level - allows us to control for a large array of fixed effects (coordinates and sector fixed effects), which we could not otherwise control for.

The second source of endogeneity is selection into treatment. It can be argued that firms needing electricity to a larger extent locate their business in places where access to electricity is higher. Concerns related to endogenous placement of firms are allayed by focusing on firms that chose their location prior to electrification. We thus exploit the time variation in firm creation and combine it with variation in the coverage of the electricity grid using older maps. The last source of endogeneity is the endogenous placement of infrastructures: the state may well target its infrastructure projects to dynamic areas in which firms need electricity. A final strategy is therefore to instrument our measure of connection to the grid using as an instrument the distance to the closest hydropower plant.

Our results suggest that access to electricity has a positive impact on firms profit in Myanmar: the delta in profits due to being connected to the grid is 1.6 percentage points higher for firms whose activity is intensive in electricity compared to firms whose activity is not. This effect, which is quite large, is even higher when using an alternative measure of sectoral intensity in electricity. The results are robust to using night light as an alternative measure of access to electricity, as well as to using two different indicators for sector intensity in electricity. A falsification test, consisting in determining randomly firms' access to the grid, also strengthens the robustness of our OLS and IV estimations.

The paper is organized as follows. The next section presents Myanmar with some background information on the country's power sector and manufacturing industry. In section 3, the data is described. Section 4 examines whether our measure of access to electricity is correlated with the perception of electricity as an obstacle to firm activity. Section 5 focuses on the relationship between firm profits and access to electricity and presents the baseline results, using the Rajan and Zingales strategy. Section 6 deals with selection into treatment and endogeneous placement of power substations. Section 7 concludes.

2 Electricity and Firms in Myanmar

Myanmar is the largest country in mainland Southeast Asia, and has a population of 51.4 million. In 2011, the government embarked on a series of reforms that led to the opening of the economy to international investors and development aid, ending a period of fifty years of isolation. With a per capita GDP around USD 1,105, one of the lowest in East Asia and the Pacific, Myanmar's medium term growth is projected to average 8.2 percent by year, led by gas production and investment (WB, 2014).

Despite having vast natural resources and abundant low-cost labor, Myanmar has not developed a strong private sector, and its potential remains highly untapped (OECD, 2013b). A large portion of Myanmar's economy relies on the primary sector: agriculture generates approximately 43% of GDP and 54% of employment. The government's private sector development agenda currently focuses on fostering manufacturers.

The manufacturing sector employs 16% of the workforce and is dominated by the food and beverage industry and by small-sized firms: three quarters of manufacturing firms have less than 50 employees (OECD, 2013a).

Electrification rates in Myanmar are remarkably low. About 70% of the population has no access to the national grid (WB, 2014), and off-grid solutions are expensive and unreliable. The per capita consumption of electricity, 20 times less than the global average, is one of the lowest in the world. Concerning the generation mix, 76% of total installed capacity is generated in hydropower plants. This raises concerns regarding the reliability of the network given its high dependence on seasonal rains. The country's vast gas reserves might help deal with seasonality; however, Myanmar sells a large share of its gas to neighbors and lacks enough back-up gas generation capacity. The government has set the objective to achieve universal access to electricity by 2030 through a National Electrification Plan. As of mid-2015, the World Bank was preparing a loan in the amount of USD 400 million for the extension of the network, which includes setting up around 12,900 miles of new power distribution lines and transformers in more than 6,300 locations, as well as decentralized electrification in remote areas (WB, 2015).

Firms' overall cost of relying on grid supply might be higher in Myanmar than in other more developed countries as a result of the poor performance of the Myanma power system. The quality of the supply is often compromised because of external events and sudden increases of demand that cannot be satisfied with actual levels of generation. Factors damaging the reliability of the supply include low density of lines catering an area, which reduces the possibilities for that area to be provided with electricity through an alternative path. Lines going through mountains, forests, high slopes or other adverse geographic features may have increased chances of suffering accidents that could shut down the supply. With regard to demand imbalances, the main underlying cause is often the lack of sufficient back-up capacity. This is the case in Myanmar, where the existing power infrastructure fails to meet current demand, resulting in frequent blackouts and the rationing of the electricity supply (World Bank, 2014).

Electricity consumption is growing fast, and electricity shortages remain large, peaking at about 30% of power demand in 2012-2013. The low reliability of the grid-based supply might force companies to own private generators in order to ensure electricity supply despite having access to the national grid. According to the World Bank Enterprise Survey 2014 for Myanmar, 85% of surveyed companies reported to own or share a generator. However, owning a generator does not imply having the ability to run it every time the grid supply becomes unreliable, due to the very high costs resulting from the operation of these engines. According to this survey, firms estimate the percentage of electricity obtained from generators at about 25%. Furthermore, connection costs are high, estimated at 2,801.7% of total income per capita in 2015 by the

World Bank Doing Business report, whereas in OECD countries connection costs stand at 73.2% of income per capita.

In vast areas of the country, access to the national grid is simply not available. However, firms not having access to the national grid may have access to off-grid electricity. Off-grid solutions typically offer expensive, unreliable power service for a few hours per day. According to data from the Myanmar Ministry of Electric Power (of Electric Power, 2013), out of 62,218 inhabited villages, 2,765 have access to the national grid and 14,195 are electrified through off-grid solutions. Following the same official source, the national grid's generation capacity is 3,615MW, while off-grid generation capacity is reported to stand at the much lower level of 100MW. 64% out of all off-grid produced electricity is originated at expensive diesel-fired generators - this figure may be larger given the fact that many generators are privately owned. The remaining off-grid electricity is generated at mini hydro plants. Positive effects of electricity on performance could highlight the importance of ensuring reliable access to electricity through an enhanced generation capacity that is able to keep up with demand. This should be possible in Myanmar, a resource-rich country. Hydro potential is estimated at 100GW, of which 40GW have already been identified and projected for exploitation (WB, 2014).

3 Data

3.1 Firm-Level Data

The main source of data for this study is the Myanmar Business Survey 2014, a cross section survey jointly conducted during the first quarter of 2014 by the Organisation for Economic Co-operation and Development (OECD), the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), and the Union of Myanmar Federation of Chambers of Commerce and Industry. This is the first-ever nation-wide survey on business sought to capture a comprehensive picture of the present business activities and environments in Myanmar. The survey covered over 3,000 firms in almost all industries and various sub-sectors, among which 994 belong to the manufacturing sector (708 for which profits is available).

The survey team did not have any target population due to the lack of a nationwide business registration/licensing system in Myanmar. Convenience, snow-balling, and seminar sampling methods, all of which are non-probability sampling methods, were used to maximize the number of responses and the accuracy of the survey. One potential drawback of this survey is that the sample is not strictly representative in a statistical sense although it covers a very large number of firms in all geographic locations. However, under the circumstances of scarce information on business, the present survey succeeds in providing the most comprehensive view currently available of the situation for firms in Myanmar (Soans and Abe, 2015).

One of the most salient characteristics of this survey is that it has a very large geographical coverage all through Myanmar, and that it provides information on the location of firms, allowing for geolocating surveyed firms. However, the degree of accuracy of the location reported by firms varies slightly. In order to maximize the accuracy of firm location, four levels of geographic aggregation are included in the data: region/state, district, township, and city/neighbourhood. The least aggregated level is the geographic coordinates (corresponding to the city/neighborhood level in most cases, or to a generic coordinate of the township if the city/neighborhood is not specified), which is the level at which errors will be clustered in the estimations. 87.7% of firms of our main sample have filled all fields in the survey related to firm location.

Geolocation of firms was carried out using different methods in order to allow for verifications.[1] Firms are allowed to report the location of up to 5 branches. Given that the information regarding performance provided by firms having different branches is not broken down into the performance of each branch, firms having branches in different locations are not eligible for a study based on geographic characteristics. An alternative could be to include firms that report different branches considering the location of headquarters as the place where the firm is based. However, in terms of access to electricity, this could distort the results greatly. Hence, firms reporting more than one branch have been dropped, as well as those firms reporting one only branch placed at a different location to the headquarters. Manual inspection also allowed for dropping firms that reported inconsistent location data. The full process involved an important reduction of the sample, from 708 manufacturing firms for which data on profits is available to 497 firms reporting one only location and profits.

Dropping those firms that show several locations and for which data on profit is not available might be leading us only to keep a selected sample of firms. Regarding profits, Table 1 suggest that the excluded and included firms are not significantly different. One major difference between the 211 firms which report multiple locations and the 497 which could be geo-located is the number of employees. Indeed, the average

[1] One of the main difficulties is the transliteration of town names from Burmese into English, that allows for different spellings while referring to the same town. Spellings have not been standardized, and different map producers (Google, Bing, MapQuest) may use different spellings. Data was first geolocated using the Stata command geocode3, which uses Google Geocode API V3 to assign coordinates to addresses. It provides an approximation and sometimes a correct result, but it tends to wrongly identify town names with street names in large cities, and it does not recognize different spellings for the same location. In order to check the results, data from the Myanmar Information Management Unit (MIMU) was used. Two kinds of data elaborated by the MIMU were used in this study. First, GIS maps of political divisions of the country. Coordinates obtained from Google Maps can be joined to these maps, so we can verify that the township, district, and state reported by Google Maps match the geographical information contained in those maps. Second, MIMU also hosts in its website a database including an exhaustive list of Myanmar villages and their coordinates, which was also used in order to increase the accuracy of the outcomes. Locations that had not been geolocated using Stata/Google Maps were geolocated using the MIMU village list manually.

size of firms is reduced from 66 employees in the sample with the 211 excluded observations to 29.4 employees in the reduced sample of 497 manufacturing firms having one only location. Fortunately, the profits are not significantly different when the sample of 708 firm is divided into small (below average) and large (above average) firms.[2]

Table 1: T-tests. Included and Excluded manufacturing firms reporting profits

	P-value	Excluded	Mean	Included	Mean
$\text{PROFIT}_{i,c,s}$	0.536	211	15.25	497	16.03
$\text{AGE}_{i,c,s}$	0.0938*	211	16.28	497	14.75
$\text{SIZE}_{i,c,s}$	0.0001***	211	66.34	497	29.39
$\text{OBSTACLE}_{i,c,s}$	0.286	183	3.16	497	3.31
$\text{FOREIGN}_{i,c,s}$	0.497	211	0.033	497	0.024
$\text{STATE}_{i,c,s}$	0.943	211	0.009	497	0.010
$\text{EXPORT}_{i,c,s}$	0.1988	208	0.192	497	0.153
$\text{COMPETITION}_{i,c,s}$	0.6205	163	3.18	497	3.25
$\text{PETROL}_{i,c,s}$	0.614	156	4.02	497	3.95

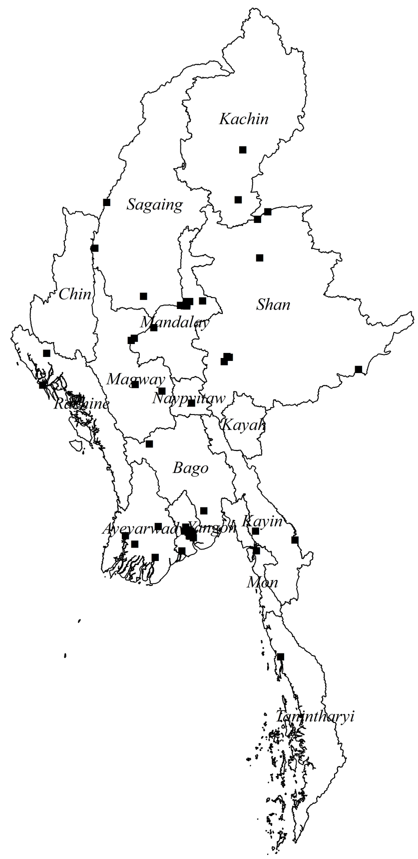
All variables are defined in the paragraph below

Despite the large reduction in the sample of manufacturing firms induced by the geolocation process, our sample is still large compared to other existing surveys, and the regions covered is a clear advantage for our analysis. As a comparison, while the 2014 World Bank Enterprise Survey in Myanmar covers 353 manufacturing firms located in five main towns, the present survey covers 497 firms for which there is complete information available located all through the territory (Figure 1).

For each firm i, located in coordinates c, and belonging to sector s, performance is measured using profits as a percentage of sales, $\text{PROFIT}_{i,c,s}$. In our estimations, we control for various firm characteristics. Selected controls include the age of the firm, $\text{AGE}_{i,c,s}$, and the number of employees, $\text{SIZE}_{i,c,s}$. We also control for the ownership of the firm: whether it is owned by the state - $\text{STATE}_{i,c,s}$ - or owned by foreigners - $\text{FOREIGN}_{i,c,s}$ -, as the structures of those firms may differ from the rest. Exporters may also have specific characteristics in their production and hence firms that export abroad are controlled for in the regressions, using a dummy variable $\text{EXPORT}_{i,c,s}$. The extent to which a firm perceives domestic competition - $\text{COMPETITION}_{i,c,s}$ - and the supply of petrol - $\text{PETROL}_{i,c,s}$ - as constraints to business is also included in the controls in order to account for different local competition patterns and local differences in the availability of petrol respectively. Both variables are scaled from 1 (low constraint) to 6 (high constraint). At some stage, we will also examine how the perception of electricity as an obstacle to firm activity - $\text{OBSTACLE}_{i,c,s}$ - relates to our measure of

[2] $\text{PROFIT}_{i,c,s}$ is on average 16.1 for small firms and 14.2 for large firms, and the difference in profits between the two sets of firms is not significant (p = 0.22).

Figure 1: Location of manufacturing firms.



Location of manufacturing firms participating in the 2014 Myanmar OECD-UNESCAP Business Survey. Thirty additional locations, where less than three manufacturing firms participated, are not shown for the sake of confidentiality.

access to electricity. As for the two previous variables, $\text{OBSTACLE}_{i,c,s}$ rates electricity as a constraint on a scale from 1 (low obstacle) to 6 (high obstacle).

Descriptive statistics are presented in Table 2. Our sample is mostly composed of relatively large, formal, and well-established manufacturing firms, with an average age of 14 years, and almost 30 employees on average. Their profits represents on average 16% of their total sales. A small share is owned by the state (only 1%) or by a foreign entity (2.4%). Finally 15% export all or part of their production abroad.

Table 2: Summary statistics. Manufacturing firms in Myanmar.

Variable	Mean	Std. Dev.	Min.	Max.	N
Firm-Level variables					
$\text{PROFIT}_{i,c,s}$	16.03	14.60	1	95	497
$\text{AGE}_{i,c,s}$	14.75	11.01	1	68	497
$\text{SIZE}_{i,c,s}$	29.40	102.1	1	1,349	497
$\text{STATE}_{i,c,s}$	0.010	0.100	0	1	497
$\text{FOREIGN}_{i,c,s}$	0.024	0.154	0	1	497
$\text{EXPORT}_{i,c,s}$	0.153	0.360	0	1	497
$\text{COMPETITION}_{i,c,s}$	3.751	1.464	1	6	497
$\text{PETROL}_{i,c,s}$	3.054	1.614	1	6	497
$\text{OBSTACLE}_{i,c,s}$	3.690	1.524	1	6	497
Coordinates-level variable					
GRID_c	0.891	0.312	0	1	497

3.2 Electricity: Connection to the Grid

We measure firm access to electricity using a dummy for the firm being based in an area covered by the national grid, GRID_c. The OECD-UNESCAP survey does not provide information on whether each firm is actually connected to the grid or not. We however can infer whether the location where the firm is based is covered by the national power grid. Information on national electric grid coverage is obtained from a PDF map of the Myanmar national grid from the Myanmar Electric Power Entreprise (2013), shown in Figure A.1 in Appendix. The PDF map is geolocated using MapGis tools for geolocation. Some other less recent maps are also available online, and this resource is precious in order to deal with endogenous location of firms, as the sample could be reduced to those firms that chose their location prior to electrification. We will notably make use of a map dating back from 2007 and presented at a Franco-ASEAN Seminar on "Powering ASEAN: Technology and Policy Options" in Bangkok (see Figure A.2 in Appendix).

There is no consensus in the literature on the method that should be used in order to determine whether a firm has access to the electric grid. Some studies use the location of power lines and consider that firms will have access to the grid if they are located within a certain distance of the power lines. This approach is used in the literature by Khandker et al. (2009). However, this method may fail at reflecting the areas that are really covered by the grid as many lines are pure transmission lines that do not distribute power into nearby locations. A second method is to create circles of a certain radius around power substations, and to consider that any given firm will have access to the power grid if the firm location falls within one of those circles. Power substations are placed close to demand, as the voltage needs to be lowered from transmission to distribution levels. This approach is used in the literature by Lipscomb et al. (2013). It will yield more satisfactory results as it reflects the functioning of power grid in a more realistic way. Furthermore there is no unique consensus on the distance that can be covered by an electric substation. Feeders departing from low voltage distribution substations are estimated to reach as many kilometres as kVs the substation has (*e.g.*, a 11kV substation should reach customers located 11 km away from the substation). However, this relationship does not hold for higher voltages, and the distance a substation can cover is highly influenced by demand and topographic conditions. While Lipscomb et al. (2013) use a 50 kilometers radius to determine access to electricity, Sivanagaraju (2008) mentions that the length of low voltage feeders in rural areas can be up to 20 kilometers. Given the topography and conditions of the Myanmar grid it is highly unlikely that substations reach locations beyond a radius of 30 kilometers. In accordance with this information, the radius of the circles around substations used to infer whether a certain location is covered by the national power grid was therefore set at the conservative distance of 30 kilometers. Table 2 shows that on average 89% of the firms have access to the electrical grid. We will provide robustness checks of our results using a 50 kilometers radius in which case we most probably consider as connected some firms that are not, hence providing an underestimation of the effect of electricity on firm performance.

4 Preliminary: Is the Electricity Constraint Lower in Connected Areas?

To get some insight on whether our measure of access to electricity is meaningful we first examine whether the perception of electricity as an obstacle by firms is linked to the availability of electricity. In Figure 2, the perception of electricity as an obstacle to business is shown by state (ranging from 1, no obstacle, to 6, very severe obstacle). States where electricity is perceived as a higher constraint include Tanintharyi, Rakhine, and Chin, three peripheral states that are not yet covered by the national power grid. Figure 3 shows the relationship between having access to the grid and deeming electricity as an obstacle. Firms that do not have access to the grid tend to see electricity as a severe constraint, whereas this trend is not found for the case of firms connected to the grid.

We further look at the correlation between declaring electricity as an obstacle and being connected to the grid. The following specification is used to estimate the effect of the availability of electricity on firm

Figure 2: Electricity as an obstacle. Manufacturing firms

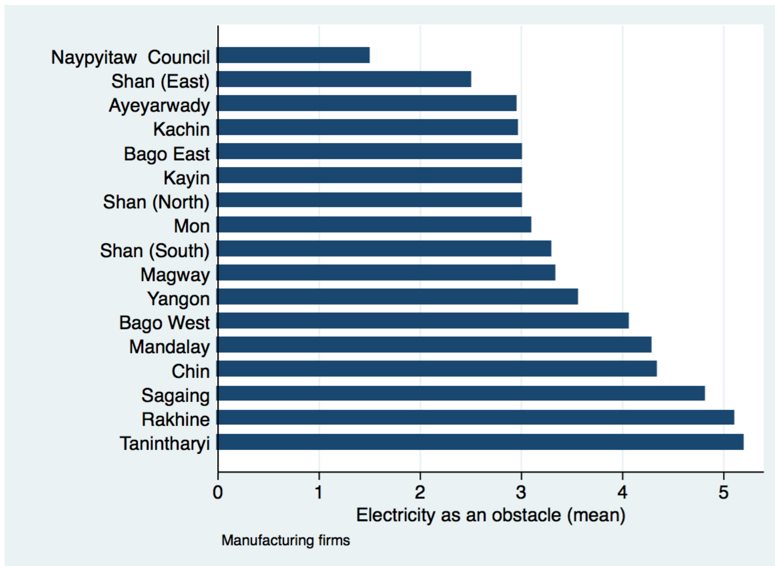
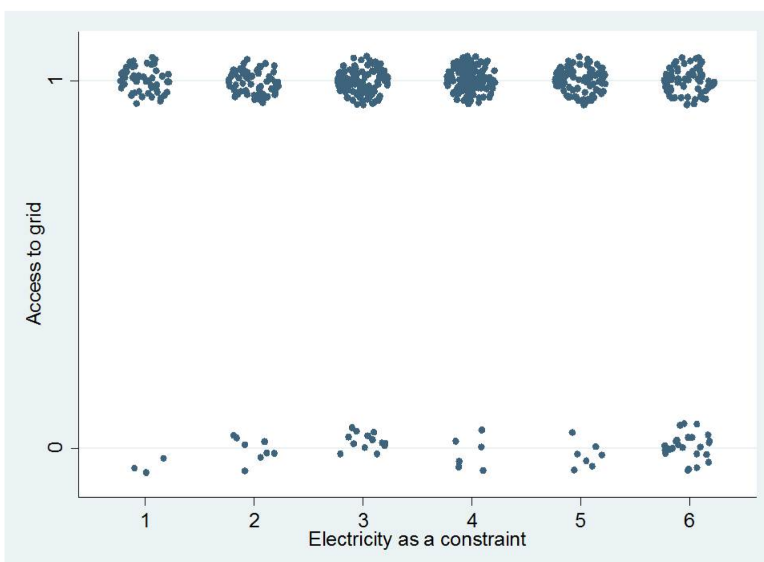


Figure 3: Electricity as an obstacle and access to the grid



perception of electricity as an obstacle:

$$OBSTACLE_{i,c,s} = \alpha GRID_c + \beta X_{i,c,s} + \gamma_s + \epsilon_{i,c,s} \tag{1}$$

where the dependent variable is electricity as an obstacle (OBSTACLE$_{i,c,s}$, ranked from 1, no obstacle, to 6, very severe obstacle) as reported by firm i, located in coordinates c, and belonging to sector of activities s. GRID$_c$ is a measure of the extent to which electricity is available in each geographic coordinate c, as detailed above. X$_{i,c,s}$ is a set of controls for each firm. Fixed effects are included for every sub-sector of activity (γ_s). Errors are clustered at the geographic coordinates level.

Table 3 presents the results of the estimation of Equation 1. Equation 1 is estimated using both a linear probability model (col. (1) and (2)) and an ordered probit (col. (3) and (4)). Table 3 shows that having access to the grid is negatively correlated with electricity being perceived by firms as an obstacle to their activity. This result is significant and robust to the inclusion of controls in columns (2) and (4). Control variables have the expected sign. Firms declaring that the supply of petrol is a large constraint also tend to see electricity as an obstacle, which may be related to the need for fuel for generators when electricity provision is not reliable. Firms seeing domestic competition as a big obstacle also tend to report electricity as a severe obstacle, which may be linked to the fact that they feel more pressure to be competitive. Finally, state-owned firms tend to report electricity as a less binding constraint.

Table 3: Electricity reported as an obstacle and access to the power grid.

Dep.: $\text{OBSTACLE}_{i,c,s}$	OLS		Ordered Probit	
	(1)	(2)	(3)	(4)
GRID_c	-0.763**	-0.902***	-0.587**	-0.818***
	(-2.06)	(-3.21)	(-2.10)	(-3.15)
$\text{AGE}_{i,c,s}$		0.000323		0.00105
		(0.06)		(0.21)
$\text{SIZE}_{i,c,s}$		0.00132**		0.00107**
		(2.03)		(2.07)
$\text{STATE}_{i,c,s}$		-0.542		-0.474*
		(-1.65)		(-1.93)
$\text{FOREIGN}_{i,c,s}$		-0.353		-0.302
		(-0.70)		(-0.73)
$\text{EXPORT}_{i,c,s}$		-0.0843		-0.0650
		(-0.43)		(-0.41)
$\text{PETROL}_{i,c,s}$		0.400***		0.338***
		(9.72)		(8.95)
$\text{COMPETITION}_{i,c,s}$		0.155***		0.130***
		(3.12)		(3.16)
Observations	497	497	497	497
Industry fixed effects	No	Yes	No	Yes
Level of clustering	Coord.	Coord.	Coord.	Coord.

t statistics in parentheses. Standard errors robust and clustered at the coordinates level. Regressions (1) and (2) estimated using OLS. Regressions (3) and (4) estimated using an ordered probit. The dependent variable, $\text{OBSTACLE}_{i,c,s}$, refers to the perception of electricity as an obstacle to business by firms and ranges from 1 (no obstacle) to 6 (very severe). Access to grid, GRID_c, is a dummy variable. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5 Impact of Electricity on Firm Profits

5.1 Model and Identification Strategy

At first sight, availability of electricity does not seem to have any significant effect on firm profits, as shown in table A.1 in Appendix. This Table presents the results of estimating the correlation between being connected to the grid and profits. We sequentially introduce controls and industry fixed effects to the specification, but the coefficient of GRID_c is never significant. This might reflect the possibility that electricity does not improve firm profits, or this may also be explained by the existence of omitted variables that could introduce a downward bias to the estimations.[3]

[3] One of the omitted variables that might introduce such bias could be competition. However, controlling in columns (2) and (4) for the perception of competition as an obstacle, $\text{COMPETITION}_{i,c,s}$, does not alter the results. $\text{COMPETITION}_{i,c,s}$ is

In order to identify a causal impact of electricity on firm profits, we rely on a similar approach to the one used by Rajan and Zingales (1998), then by Nunn (2007) and Levchenko (2007). This method helps overcome the problem of omitted variables by allowing for the introduction of location and sub-sector fixed effects. The underlying intuition is that access to electricity should bring disproportionate larger gains to firms belonging to sectors of activity that typically need electricity to a larger extent *i.e.* firms which activity is more electricity intensive. This methodology entails the use of an indicator, INTELEC_s, that corresponds to an exogenous measure of intensity in electricity of each sub-sector s. The indicator is interacted with a measure of access to electricity GRID_c in a specific location c. The introduction of an interaction term (ELEC_c x INTELEC_s) allows to correct for location fixed effects γ_c and for industry fixed effects δ_s, so concerns regarding the existence of time-invariant omitted variables are allayed, as mentioned above. The specification used is as follows:

$$PROFIT_{i,c,s} = \alpha GRID_c.INTELEC_s + \beta X_{i,c,s} + \gamma_c + \delta_s + \epsilon_{i,c,s} \tag{2}$$

This method allows to analyze whether industries that structurally depend on electricity to a larger extent show better performance in locations where electricity is more available. This approach accounts for the fact that electricity access does not impact every sector of activity in the same way. Electricity is likely to be a constraint to electricity intensive industries (*e.g.* chemicals) while for some other sectors of activity electricity access might not foster large performance improvements (*e.g.* wood products). Electricity intensity therefore allows to measure the extent to which a certain industry relies on electricity for production.

The measure of intensity in electricity has to be exogenous to firm performance. The idea is to use a measure of sector intensity in electricity that reflects the consumption of electricity in a well-functioning infrastructure environment. We use the energy intensity of US manufacturing firms as a benchmark measure since US manufacturing firms are assumed to operate under a regime close to perfect competition and thus use their resources in the most efficient way. This approach assumes that the extent to which US firms need electricity is an accurate measure of the needs in electricity of firms in the same industry elsewhere.

The intensity in electricity of US manufacturing firms, INTELEC_s, is obtained from the Office of Energy Efficiency and Renewable Energy (EERE). The index has been built for manufacturing firms, averaging the Energy Intensity indicator, measured in kBtu per USD of gross output, from 2001 to 2011, by sector. Averaging over 10 years prevents temporary changes in consumption patterns that could be linked to market conditions from affecting the final index. After merging industries included in the EERE database with

only a rough approximation for the degree of competition faced by firms.

industries in the Myanmar Business Survey 2014, this index allows the creation of 16 different categories of industries in the manufacturing sector. Table A.2 in Appendix presents the value of the intensity indicator for each industry. In line with what we would expect, heavy manufacturing industries such as chemicals, plastics and rubber, or textile seem to be more intensive in electricity.

Table 4: Summary statistics. Electricity intensity indices.

Electricity intensity	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
INTELEC_s	0.585	0.329	0.269	1.581	497
INTELEC_s IEA measure	0.504	0.219	0.207	1.000	435

As a robustness check we will also use another index, INTELEC_s IEA, that has been built using the International Energy Agency database which provides electricity consumption of several industries. This dataset is combined with value added data of the OECD STAN database, measured in volume. The index has then been normalized so that it varies from zero to one. This index however depends on the specificities and aggregations of each country's national accounts, and diminishes the number of different categories of industries. Table A.2 in Appendix presents this indicator for the sectors for which it could be computed. Summary statistics for both electricity intensity indicators are presented in Table 4. The correlation of the two intensity indicators is 0.644.

5.2 Baseline Results

Estimation of equation 2 is presented in columns (1) and (2) of Table 5. Results in Table 5 show that the impact of being connected to the grid on profits is positive and significant when control variables are included in the estimation. Column (2) suggests that electricity intensive firms see a reduction in their costs when they are located in areas covered by the grid. The possible negative effects on profits triggered by the unreliability of the grid does not seem to overcome the gains of being located in an area where electricity supply from the grid is available. In order to get a sense of what the interpretation of the coefficient could be, we have calculated the differential in profits (see last row of Table 5) which measures the extent to which a firm at the 75th percentile level of dependence on electricity reports larger profits with respect to an industry located at the 25th percentile level when such firm is based at a location with access to electricity (GRID_c = 1) rather than at a location with no electricity ($\text{GRID}_c = 0$). It suggests that the delta in profits due to connection to the grid would be higher by 1.6 percentage points for the firms which activity is intensive in electricity compared to the firms which activity is not.

Table 5: Manufacturing firms' profits and access to electricity.

Dep.: $\text{PROFIT}_{i,c,s}$	GRID_c		LIGHT_c		INTELEC_s IEA	
	(1)	(2)	(3)	(4)	(5)	(6)
GRID_c x INTELEC_s	13.67	16.10*				
	(1.53)	(1.68)				
LIGHT_c x INTELEC_s			202.5**	171.6*		
			(2.07)	(1.86)		
GRID_c x INTELEC_s IEA					26.50**	27.46**
					(2.37)	(2.36)
$\text{AGE}_{i,c,s}$		0.145**		0.131**		0.158***
		(2.38)		(2.18)		(2.77)
$\text{SIZE}_{i,c,s}$		0.0104		0.0113		0.0132
		(1.31)		(1.21)		(1.48)
$\text{STATE}_{i,c,s}$		3.728		2.997		2.730
		(0.37)		(0.29)		(0.28)
$\text{FOREIGN}_{i,c,s}$		7.109**		7.374*		8.575**
		(2.15)		(1.96)		(2.46)
$\text{EXPORT}_{i,c,s}$		5.990		5.299		3.699
		(1.61)		(1.44)		(0.90)
$\text{PETROL}_{i,c,s}$		-0.398		-0.229		-0.333
		(-0.76)		(-0.47)		(-0.69)
$\text{COMPETITION}_{i,c,s}$		0.208		0.173		0.0901
		(0.32)		(0.27)		(0.13)
Observations	497	497	497	497	435	435
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Location fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Level of clustering	Coord.	Coord.	Coord.	Coord.	Coord.	Coord.
Differential in profits	1.403	1.653	0.685	0.581	8.189	8.486

t statistics in parentheses. Robust standard errors, clustered at the coordinates level. OLS estimates. The dependent variable is firms' profits as a percentage of sales, $\text{PROFIT}_{i,c,s}$. Access to grid, GRID_c, is a dummy variable. LIGHT_c is the night light intensity per capita. The differential in profits shows the extent to which a firm at the 75th percentile level of dependence on electricity reports larger profits with respect to an industry located at the 25th percentile level when such firm is based at a location with access to the national power grid.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The robustness of the baseline result has to be tested on two grounds: the measure of access to electricity, and the measure of the intensity in electricity. In columns (3) and (4) of Table 5 we present the results when an alternative proxy for access to electricity is used. More specifically, we substitute a measure of access to electricity based on night lights, LIGHT_c, to the GRID_c variable used so far. This alternative proxy of access to electricity is a ratio of night lights to population. Night lights data are extracted from the Version

4 Defense Meteorological Satellite Program Operational Line Scanner (DMSP-OLS) Nighttime Lights Time Series, collected by the US Air Force Weather Agency and processed by NOAA's National Geophysical Data Center.[4] Instead of using plain night lights data, a better proxy for electricity access is a ratio of the intensity of night lights data to the population of the same area. Data of the population have been obtained at the WorldPop project website in order to estimate the population living in a certain zone. Circles of a radius of 3 kilometers around the location of firms are created in order to measure the night lights to population ratio and thereby obtain a measure of access to electricity.[5]

Columns (3) and (4) of Table 5 suggest that the results are robust to using this alternative measure of access to electricity. The magnitude of the impact is lower than in the previous two columns, though. The increase in profit of the firms belonging to the 75th percentile of LIGHT_c compared to those belonging to the 25th percentile would be higher by 0.6-0.7 percentage points for the firms which activity is intensive in electricity compared to the firms which activity is not.

The second robustness test concerns the measure of the sectoral intensity of electricity. Columns (5) and (6) of Table 5 present the results when INTELEC_s is computed using the International Energy Agency (IEA) data. The results are very similar to the baseline presented in columns (1) and (2), but the impact computed in the last row of the Table is much higher (8 times higher).

Finally, in Appendix A.3 we also show estimations of columns (1), (2), (5), and (6) of Table 5 but measuring GRID_c with a 50 (instead of a 30) kilometers radius. The results seem to be robust to this change in definition.

[4]These data cover the period 1992-2013 and are available on a year-by-year basis. This database attributes to each cell a number from zero, which is total darkness, to 63. The cleaned up dataset contains cloud-free composites made using all the available archived DMSP-OLS smooth resolution data for calendar years. This dataset contains the lights from cities, towns, and other sites with persistent lighting, including gas flares. Ephemeral events, such as fires have been discarded, and the background noise was identified and replaced by zero. Although areas with zero cloud-free observations are reported to be represented by the value 255, the maximum value found in the 2013 database is 63. The DSMP-OLS has no on-board calibration and the gain settings are not recorded in the data stream, which makes images from different years not to be strictly comparable.

[5]The map used for this study is the 2010 estimate of numbers of people per grid square (0.000833333 decimal degrees, approximately 100m at the equator), with national totals adjusted to match UN population division estimates. All the work with maps was carried out using MapGis. The choice of the radius responds to the need for an indicator that accounts for the inexact location of firms (as the coordinates belong to the town the firm is based in) but is also small enough to show significant local information. Radiuses larger than 3 kilometers proved unreliable in measuring the variation of night-light intensities. Both the Version 4 DMSP-OLS Nighttime Lights Time Series and the WorldPop maps use the WGS 84 geographic projection, which does not allow to measure distances in a reliable way. Maps were reprojected into the South Asia Conic Equidistant Projection, EPSG 102029, as well as the rest of geographic features. Focal statistics were used to create new maps where each point holds the old maps' average value of circles around each point, and then such values were extracted to the points where firms are located.

6 Robustness Checks

The identification strategy implemented so far mostly accounts for omitted variable bias. Two other sources of endogeneity may be at play in our framework: selection-into-treatment - firms needing electricity the most, and being more profitable, relocate close to electricity power station; and the endogenous placement of electricity infrastructures - areas with dynamic and profitable firms benefit from improvement of infrastructure. In what follows, we examine both sources of endogeneity bias in turn.

6.1 Endogenous Selection of Firm Location

Firms needing electricity the most may choose to be based in areas covered by the national power grid. Firms locating according to the provision of electricity may also be those which are the most profitable inducing a selection bias in the previous estimations. Indeed, while the approach presented before deals with the problem of omitted variables, through the introduction of industry and location fixed effects, selection bias has not been addressed yet. In order to account for the possibility of endogenous placement of firms, we use a 2007 map of the national power grid (see Figure A.2 in Appendix). By comparing that map with the map used throughout the rest of the study (dating from mid-2013), this approach allows to identify which areas of the country have been electrified between 2008 and 2013. Columns (1) and (2) of Panel A in Table 6 shows the results of estimating equation 2 keeping only firms that were created before 2008, as a first step before further reducing the sample. The coefficient of the interaction term, GRID_c x INTELEC_s, is robust to reducing the sample on the 'old' firms, created before 2008.

In order to deal with the selection issue, we estimate equation 2 for firms that were created before 2008 and that did not have access to electricity at that time. We are therefore keeping two groups of firms: the firms located in areas that were electrified after 2007 and the firms located in areas that are still not electrified as of mid-2013.

This allows to reduce the selection-into-treatment issue, since we are now comparing firms that located in the connected area before the connection occurred to firms that are not connected in 2013. The results are presented in columns (3) and (4) of Panel A. The coefficient of GRID_c x INTELEC_s remains positive, though now being losing its significance (p-value is 0.105 in column (3) and 0.135 when adding controls in column (4)). This loss of significance may partly be due to the loss of power induced by the reduction in the sample (107 firms).

Panel B of Table 6 reproduces the estimations when the alternative measure of INTELEC_c - computed by the IEA - is used. The results are very similar to those of Panel A, but with a larger impact of connection to the grid, as suggested by the differential in profit computed in the last row of the Panel.

Table 6: Endogenous selection of firm location.

Dep.: $PROFIT_{i,c,s}$	CREATED BEFORE 2008		CREATED BEFORE 2008 NOT CONNECTED IN 2007	
	(1)	(2)	(3)	(4)
Panel A				
$GRID_c$ x $INTELEC_s$	17.68*	19.95*	33.09 (p=0.105)	31.47 (p=0.135)
	(1.72)	(1.84)	(1.70)	(1.56)
Differential in profits	1.815	2.048	3.397	3.230
Observations	368	368	107	107
Panel B				
$GRID_c$ x $INTELEC_s$ IEA	29.41***	27.77**	33.64*	34.35*
	(2.82)	(2.47)	(2.00)	(1.80)
Differential in profits	9.088	8.581	10.395	10.615
Observations	323	323	95	95
Firm-level controls	No	Yes	No	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Location fixed effects	Yes	Yes	Yes	Yes
Level of clustering	Coord.	Coord.	Coord.	Coord.

t statistics in parentheses. Robust standard errors, clustered at the coordinates level. OLS estimates. The dependent variable is firms' profits as a percentage of sales, $PROFIT_{i,c,s}$. Access to grid, $GRID_c$, is a dummy variable. The differential in profits shows the extent to which a firm at the 75th percentile level of dependence on electricity reports larger profits with respect to an industry located at the 25th percentile level when such firm is based at a location with access to the national power grid. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

6.2 Endogenous Placement of Infrastructure

Reverse causality and endogeneity in the placement of electricity infrastructure may also be a major issue: firms being very electricity intensive may locate in places where electricity is indeed available, and wise planners may provide electricity infrastructure to buoyant economic centers.

In order to account for the endogenous placement of infrastructure, we implement an instrumental variable strategy. Two different kinds of geographic instruments have been used in the literature. First, connection to the grid could be instrumented with gradient, as used by Dinkelman (2011) and Grogan and Sadanand (2012) - land gradient -, and Duflo and Pande (2007) - river gradient -, or Lipscomb et al. (2013) - cost factors linked to gradient. Land gradient is reported to be one of the main determinants for calculating the cost of deploying power lines. In order to decrease costs, the line should run along the least slope. However, the impact of land gradient, while possibly large when electrifying small areas close to the existing grid, is less plausibly a criterion for developing the grid from a country-wide perspective. The validity of river gradient as an instrument is discussed by Ravallion (2007). He points out to the fact that for most crops land gradient is a key factor affecting productivity, in a positive or negative way depending on the variety. Gradient may also be the underlying cause of variations of intermediary inputs' prices and may also condition the access to other kinds of infrastructure, such as roads. These facts would potentially invalidate the IV.

A second strategy entails access to electricity being instrumented with distance from the firm to the nearest hydropower plant. This instrument has already been used in the literature by Van de Walle et al. (2013), Grogan (2012) and Lewis and Severnini (2014). The latter IV strategy is more likely to work in the context of Myanmar since hydropower plants' location is less likely to be endogenous as it probably depends instead on the availability of natural resources. Furthermore, the fact that 76% of power generation in Myanmar is hydro-based increases our instrument's chances to be effective. The exclusion restriction requires that decisions over the location of power plants were not made based on the economic activity of newly electrified areas, but on topographic features or long-term projected demand. This seems to be the case of Myanmar's hydropower plants, as they can only be placed where the resource is available and where topographic features allow to do so.

We therefore instrument having access to the national power grid with distance to the closest hydropower plant in kilometers. Descriptive statistics of the variable distance to the closest hydropower plant can be found in table 7.

Table 7: Summary statistics. Distance to hydropower plants.

Instrumental Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
HYDROPOWER_c	97.332	58.452	15.707	454.258	497

Results of the IV estimation of Equation 2 are presented in columns (1) and (2) of Panel A in Table 8. The difference between the two columns stems from the way INTELEC_s is measured (the IEA indicator is used in column (2)). The interaction term is positive, significant and has the same order of magnitude as in previous estimations. The instrument, distance to power plants, HYDROPOWER_c, is also interacted with INTELEC_s. As shown in Panel B of Table 8, it is significant in the first stage and negative as expected (as longer distances would imply a lower probability of being connected to the grid). The differential in profits remains in the same order of magnitude of former estimates.

Table 8: IV estimation of the impact of the access to the grid on firms' profits.

	IV (1)	$INTELEC_s$ IEA (2)	EXCLUSION (3)	REDUCED (4)
Panel A - IV estimation				
$GRID_c$ x $INTELEC_s$	36.57^{***}	41.99^{***}	46.99^{***}	
	(2.96)	(2.78)	(3.44)	
$WATER_c$ x $INTELEC_s$			0.470^{***}	
			(2.81)	
Panel B - First stage results				
$HYDROPOWER_c$ x $INTELEC_s$	-0.0044^{***}	-0.0039^{***}	-0.0041^{***}	
	(-3.80)	(-3.59)	(-3.46)	
Panel C - Reduced form				
$HYDROPOWER_c$ x $INTELEC_s$				-0.163^{***}
				(-2.99)
Observations	497	435	497	497
Centered R squared	0.38	0.42	0.38	0.39
Control variables	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Location fixed effects	Yes	Yes	Yes	Yes
Level of clustering	Coord.	Coord.	Coord.	Coord.
Differential in profits	3.754	12.976	3.715	
Kleibergen-Paap LM stat. (p-value)	0.0051	0.0036	0.0046	
Kleibergen-Paap F-stat.	14.442	12.883	11.97	

t statistics in parentheses. Robust standard errors clustered at the coordinates level. Columns (1) to (3) IV estimations. Column (4), OLS estimation. The dependent variable is firms' profits as a percentage of sales, $PROFIT_{i,c,s}$. The interaction term of access to the grid with the electricity intensity index is instrumented with the distance to the closest hydropower plant interacted with the same electricity intensity index, $HYDROPOWER_c$ x $INTELEC_s$. Underidentification stems from the Kleibergen-Paap rk LM statistic. The weak identification test stems from the Kleibergen-Paap rk Wald F-statistic. Stock-Yogo weak identification test critical value at 10% is 16.38, at 15% is 8.96 and at 20% is 6.66. The differential in profits shows the extent to which a firm at the 75th percentile level of dependence on electricity reports larger profits with respect to an industry located at the 25th percentile level when such firm is based at a location with access to the national power grid. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

In order for the exclusion restriction to hold, the only channel through which the location of hydropower plants affects firm profits must be through increased access to electricity. However, distance to hydopower plants may proxy the distance to water bodies which might be correlated with firm profits. In column (3) of Table 8 we address concerns related to the exclusion restriction by controlling for the distance to the closest water body, $WATER_c$ interacted with the intensity in electricity variable, $INTELEC_s$.[6] Data on water bodies in Myanmar have been obtained from the Digital Charter of the World. Distance to water bodies is significantly positive, and including it leads to virtually the same results as those obtained without this

[6]If not interacted with $INTELEC_s$, $WATER_c$ drops because of the location fixed effects.

control. Finally, column (4) in Panel C of Table 8 shows the reduced form of the model, which as expected displays a significantly negative coefficient of HYDROPOWER_c on firm profits.

6.3 Falsification Test

As a last robustness check, we run a simple falsification test in which GRID_c is randomly assigned to one. We provide this falsification test on the baseline result when controlling for firm level covariates, using both the OLS and IV estimators, corresponding respectively to column (2) of Table 5 and column (1) of Table 8. We provide 300 replications for each random draw. First, we randomly assign the value one to the variable GRID_c for 443 firms, which is the number of connected firms in the baseline results. We then conduct the same exercise for 455 and 430 firms that are randomly chosen and considered to be connected to the grid.

Table 9 shows the results. Both in OLS (Panel A) and IV (Panel B) a very small proportion of the replicated estimations leads to a significant coefficient of GRID_c x INTELEC_s - between 3 percent and 7.7 percent of the estimations display a significant coefficient. Moreover, the coefficient has on average the wrong sign. Results presented in Table 9 suggest that assigning randomly firm connection to the grid does not lead to the significantly positive coefficient found both in OLS and IV baseline estimations.

Table 9: Falsification test.

Nb of firms randomly drawn to assign $\text{GRID}_c = 1$ 300 replications	443 (1)	455 (2)	430 (3)
Panel A - OLS Coefficient of GRID_c x INTELEC_s			
Mean	-0.254	-0.072	0.083
Standard deviation	3.246	3.830	2.829
Percent significant	4.33	7.67	4.33
Panel B - IV Coefficient of GRID_c x INTELEC_s			
Mean	-132.7	-75.9	-140.5
Standard deviation	1855.6	2620.9	1198.3
Percent significant	3.33	3.33	3.00
Observations	497	497	497
Firm-level controls	yes	yes	yes
Industry fixed effects	yes	yes	yes
Location fixed effects	yes	yes	yes
Level of se clustering	Coord.	Coord.	Coord.

In Panel A, estimations are run using the OLS estimator. In Panel B estimations are run using the IV estimator, were GRID_c x INTELEC_s is instrumented with HYDROPOWER_c x INTELEC_s. All estimations include firm-level control variables. All estimations also include industry and location fixed effects, and robust standard errors clustered at the coordinates level. ***p<0.01, **p<0.05, *p<0.1.

7 Conclusion

The present study investigates how the access to electricity affects Myanmar manufacturing firm performance. In Myanmar, the perception of electricity as an obstacle to business is closely linked to the local availability of electricity. The present study shows that the access to electricity provided by the national power grid has a positive impact on firm profits. This result is robust to using an alternative measure of access to electricity, based on night lights, and to using an alternative measure of sector intensity in electricity. It is also robust to reducing the sample to firms that located in the connected areas before it was connected in order to address the selection-into-treatment issue. It is robust to implementing an instrumental variable strategy to correct for the endogenous placement of power substations. Finally it is robust to a falsification test in which connection to the grid is randomly assigned to the firms.

Low access to electricity might not only be one of the causes of the underdevelopment of the country's private sector, but may also be leading existing firms to show worse performance indicators. This study shows that firms belonging to industries that tend to make more intensive use of electricity report higher profits if they are located in areas covered by the national power grid. This work aims to contribute to the analysis of the role electricity has in firm performance in transitioning Myanmar, at a time when deep power sector reforms are expected and an ambitious plan of expansion of the national grid is under way.

Policy implications of this study are related to the establishment of investment priorities in the power sector. Provided that a positive significant effect has been found, the policy implication would be to encourage efforts towards the expansion of the national grid. Such positive result might constitute an argument favoring large investments in service expansion, as larger profits obtained by manufacturing firms covered by the grid may attract more people into manufacturing thereby fostering the structural transformation the government seeks to promote. Notwithstanding that, decentralized approaches may be the most pertinent solutions in some cases, especially for remote areas. Education efforts are also capital to let businesses make the most of electricity access so that accurate estimations of demand lead to wise and profitable investment decisions in electric appliances.

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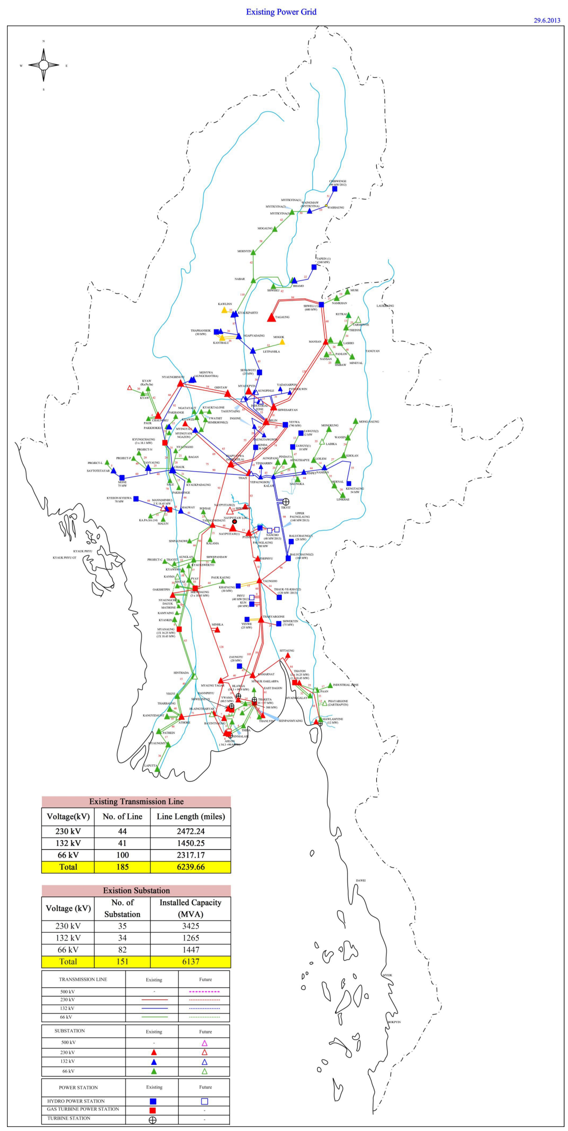
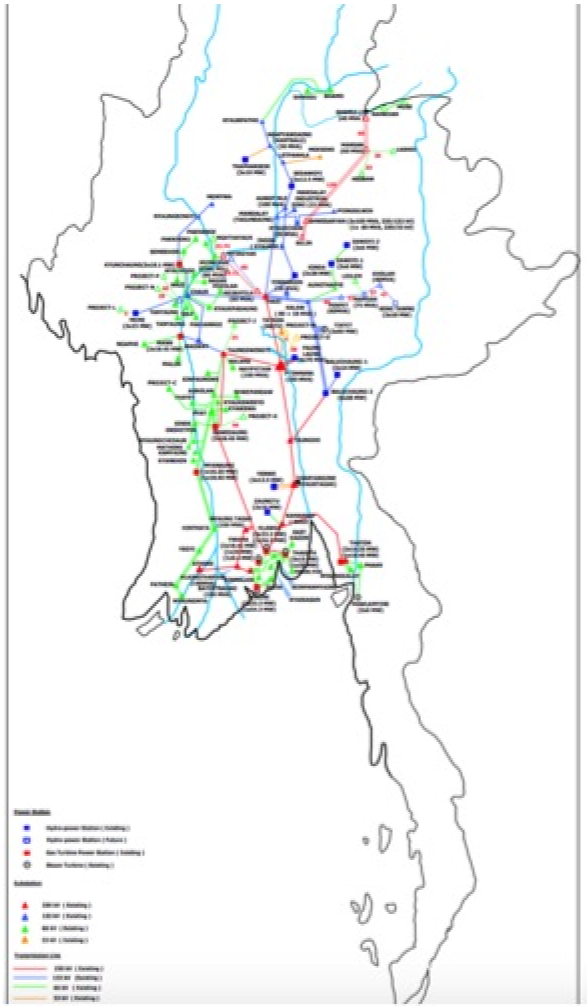
Appendix A

Figure A.1: *Existing power grid in Myanmar as of June 2013*



Obtained from the Myanmar Electric Power Enterprise. June 2013.
http://www.ubifrance.com/medias/press/mepe_9_7_2013_29_31.pdf. (Last accessed May 26, 2015).

Figure A.2: *Existing power grid in Myanmar as of 2007*



Obtained from the Franco-ASEAN Seminar on "Powering ASEAN: Technology and Policy Options". http://www.ibiblio.org/obl/docs2/MMpresentation.pdf (Last accessed May 26, 2015).

Table A.1: Access to the grid and profits.

	(1) $\text{PROFIT}_{i,c,s}$	(2) $\text{PROFIT}_{i,c,s}$	(3) $\text{PROFIT}_{i,c,s}$
GRID_c	-2.275	-2.069	-2.441
	(-0.82)	(-0.79)	(-0.92)
Observations	497	497	497
Controls	No	Yes	Yes
Industry fixed effects	No	No	Yes
Level of clustering	Coord.	Coord.	Coord.

t statistics in parentheses. OLS estimations, Robust standard errors, clustered at the coordinates level. Firm-level controls include $\text{AGE}_{i,c,s}$, $\text{SIZE}_{i,c,s}$, $\text{STATE}_{i,c,s}$, $\text{FOREIGN}_{i,c,s}$, $\text{EXPORT}_{i,c,s}$, $\text{COMPETITION}_{i,c,s}$, and $\text{PETROL}_{i,c,s}$. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.2: Correspondence of industries for the construction of indices showing intensity in electricity

Survey	NAICS	EERE (USA) Sector	EERE (USA) Intensity	OECD STAN	IEA Sector	IEA Intensity
9, 10	311, 312	Food, Beverages and Tobacco	0.459	D10T12 Food products, beverages and tobacco	Food and tobacco, includes beverages	0.429
11	313,314	Textile and textile product mills	1.210	D13T15 Textiles, wearing apparel, leather and related prodcuts	Textile and leather	0.738
12,13	315,316	Apparel and leather and allied products	0.323			
14	321	Wood	0.829	N/A	*Wood and wood products, excl. furniture*	
15	322	Paper	1.582	D17 Paper and paper products	Paper pulp and printing	1
16	323	Printing and Related Support	0.564	D18 Printing and reproduction of recorded media		
17	324	Petroleum and Coal Products	0.363	*D19 Coke and refined petroleum products*	N/A	
18	325	Chemicals	0.952	D20T21 Chemical and pharmaceutical products	Chemical and petrochemical	0.856
19	326	Plastics and Rubber Products	1.079	*D19T23 Chemical, rubber, plastics, fuel products and other non-metallic mineral products*	N/A	
20	327	Nonmetallic Mineral Products	1.426	D23 Other non-metallic mineral products	Non-metallic minerals	0.551
22	332	Fabricated Metal Products	0.563	D25 Fabricated metal products, except machinery and equipment	Machinery, fabricated metal products, equipment	0.207
23	333	Machinery	0.331	D26T28 Machinery and equipment		0.207
24	334	Computer and Electronic Products	0.292			
25,26,27	335	Electrical Equip., Appliances, and Components	0.461			
28,29	336	Transportation Equipment	0.270	D29T30 Transport equipment	Transport equipment	0.336
30	337	Furniture and Related Products	0.384	*D31T32 Furniture, other manufacturing*	N/A	

In italics, sectors for which part of the information is missing (either value added or electricity intensity).

Table A.3: Alternative radius to define $GRID_c$.

Dep.: $PROFIT_{i,c,s}$	$GRID50_c$	
	(1)	(2)
Panel A		
$GRID_c$ x $INTELEC_s$	17.40**	19.85**
	(2.06)	(2.17)
Observations	497	497
Differential in profits		
Panel B		
$GRID_c$ x $INTELEC_s$ IEA	26.97**	28.33**
	(2.30)	(2.33)
Observations	435	435
Firm-level controls	No	Yes
Industry fixed effects	Yes	Yes
Location fixed effects	Yes	Yes
Level of clustering	Coord.	Coord.

t statistics in parentheses. Robust standard errors, clustered at the coordinates level. OLS estimates. The dependent variable is firms' profits as a percentage of sales, $PROFIT_{i,c,s}$. Access to grid, $GRID50_c$, is a dummy variable which is equal to one for firms located in a 50 kilometers radius from the grid. The differential in profits shows the extent to which a firm at the 75th percentile level of dependence on electricity reports larger profits with respect to an industry located at the 25th percentile level when such firm is based at a location with access to the national power grid. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

“Sur quoi la fondera-t-il l’économie du monde qu’il veut gouverner? Sera-ce sur le caprice de chaque particulier? Quelle confusion! Sera-ce sur la justice? Il l’ignore.”

Pascal

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