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Unveiling the Nexus between Access to Electricity, Firm Size and SME's Performance in Bangladesh: New Evidence Using PSM

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Abstract: Uninterrupted availability of energy and power resources is essential for the productivity and smooth functioning of an enterprise. However, constrained by financial resources, smaller firms in developing economies face a plethora of challenges concerning the access to electricity. However, less attention has been paid in the extant literature to explore this phenomenon. The present study investigates the impact of access to electricity on labor productivity in Bangladesh in the presence of electricity constraints, electricity obstacles, and SME firm size. It employs the OLS regression and propensity score matching (PSM) technique for treatment effect to deal with the selection bias and endogeneity issue using the World Bank Enterprise Survey's cross-sectional firm-level data for 3196 sample firms over the period of 2007–2013. The results provide evidence in support of SMEs' labor productivity in response to electricity access. Lack of electricity access was partially found to affect SMEs' labor productivity significantly negatively. Further, the results show a positive impact of firm size on firm performance. However, results from this model appear that constrained SMEs' access to electricity has a negative relationship with firm performance. The article then suggests several policy implications on changing government regulations regarding the efficient use of renewable energy resources to enhance electricity generation for optimized SME performance and sustainable economic development in Bangladesh.

Keywords: access to electricity; firm performance; small and medium-sized enterprises (SMEs); propensity score matching technique; Bangladesh

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1. Introduction

Smaller and poverty stricken economies face the dilemma of a substantial energy shortfall which hinder their ability to fuel rapid economic development. The growth of small and medium-sized enterprises assists domestic economic development in developing and under-developing countries since small firms generate jobs, return on investments, and more economic synergy among small and medium enterprises, boosting the domestic multiplier outcome in companies [1,2]. Small and medium firms contribute more to creating employment than large firms [3,4]. However, labor productivity in low and middle-income countries is crucial to identify the impact of key drivers of a firm's performance rather than more developed nations [5,6].

Constraint in access to electricity due to high costs, inadequate expansion in the electricity sector, power outages, and vulnerable supply may lead to poor productivity and hinder the participation of firms on a larger scale in low-and middle-income countries [7]. The gap between the increasing demand for electric power and inadequate supply indicates the main reason for the firms' electricity shortage. The electricity shortage due to the demand-supply gap may create electricity constraints in the industry, affecting productivity in various ways [8]. Electricity shortages may drive firms to invest in costly fuel captive generators, pulling capital away from more profitable actions. In addition, firms must shut down businesses due to the unavailability of alternate power sources. It induces waste of labor and certain production inputs which may be damaged by an electricity failure [9]. Again, production costs may significantly increase due to power shortage because firms may purchase electricity from expensive sources to minimize the impacts of regular electricity shortage [10].

Furthermore, the firm size–labor productivity association has many significant implications. Adopting good management practices is linked to an increase in labor productivity for small and medium firms [11]. Similarly, according to [12], managerial capabilities in SMEs were found to be a vital factor for labor productivity. Recently, Bessonova (2020) [13] noted that labor and capital redistribution accelerate labor productivity and turn small and medium enterprises from inefficient to efficient firms. Again, [14] exhibit the significance of the labor productivity-firm size relationship for both Canadian manufacturing and non-manufacturing firms and explained to what extent employment distribution over firm size affects aggregate productivity in Canadian firms.

In addition, access to electricity is widely known as a vital factor in ensuring industrial development and sustainable economic growth of most firms and businesses. Rud (2012) [15] mentioned electricity consumption and infrastructural development of electricity generation are positively correlated with economic development and firm growth. Adenikinju [16] and Rud [15] contend that infrastructural development plays a vital and significant role in firm performance [17]. Likewise, Khandker [18] argued that in South Asian countries, electricity access is not the only obstacle but also negatively correlated to sales growth for small and medium-sized firms. According to a report, Bangladesh is ranked 168th worldwide when it measures the electricity supply quality. In 2013, the country measured the electricity supply quality, and the total energy production capacity was 5719 MW. However, out of this total generation capacity, only 4162 MW was consumed due to lack of infrastructure and energy loss [17]. Therefore, electricity access for most of the population and businesses in the country is still a far cry. However, one notable study attempted to investigate the link between electricity access and the performance of firms in Bangladesh. In his study, Ahmed [19] revealed that lack of electricity access is one of the vital constraints of SMEs' growth and development in Bangladesh. In order to provide some solutions, Haque [20] discussed the causes of the energy crisis due to the demand-production gap. Yet, the relationship between access to electricity and firms' size and how their inter-relation affects firms' labor productivity is still unexplored. Moreover, these above mentioned studies did not apply robust econometric methods required to create pragmatic policy recommendations. Therefore, this research, seeks to fill this gap.

This article aims to establish the impact of both access to electricity classified as electricity constrained and electricity obstacle, and firm size denoted as the number of employees; on SME labor productivity, respectively, in Bangladesh. It is essential because SMEs face low productivity issues as key challenges in under-developing and developing countries. This research also designs to examine the separate effect of electricity-constrained small and medium firms on labor productivity.

The research contribution is threefold. The major contribution of this article associates to more focused investigation on the interaction effect of firm size and electricity access, and how their interplay influences SMEs labor productivity in the context of Bangladesh. Bangladesh is a developing economy in South Asia where SMEs play an imperative role in providing livelihood and employment opportunities to the masses. Hence, it is crucial to

examine how an uninterrupted access to energy resources and electricity can ameliorate the performance of smaller firms and enhance the overall productivity and income level of labor class in the country. The second contribution relates to investigating firm size effect via examining the individual effects of electricity-constrained small and medium firms on labor productivity. Although investment in the self-generation of electricity may be costly for small and medium-sized firms, the gains from integration may offset the sunk cost to enhance infrastructural advantage and benefit from achieving high revenues [21]. In turn, infrastructural development and self-generation of SME firms' electricity ownership may be positively interrelated with firm productivity [21–24]. To the best of our knowledge, this is a pioneering research along with significant contribution associates to more focused investigation on the interaction effects of firm size and electricity access, and how their interplay affects SMEs labor productivity in the context of developing countries. We hope that the paper will open the pathway towards further research on electricity constraints with firm size along with other productivity factors.

Finally, the addition of treatment effects through the propensity score matching (PSM) methodology makes an utmost contribution to our approach. Using sample data to develop comparable observations of firms along with access to electricity to assume causal effects of a treatment on an event and, thus, to alleviate the endogeneity issue due to selection bias. PSM technique can alleviate self-selection, like the simultaneous interaction between access to electricity and firm productivity.

The remaining part of the study is designed as follows. In Section 2, a brief review of related literature and the research hypothesis are presented. Section 3 highlights the data source and methodology of the research. Empirical results are shown in Section 4. Section 5 shows the discussions and the policy implications, and Section 6 gives the conclusion, along with limitations and scope for future research drawn from the study.

2. Literature Review

Small and medium enterprises are key players in job creation and employment across various income pools. They have more significant revenue growth than large enterprises, describing the faster booming of SMEs' in middle-income countries [4–25]. However, most small and medium firms mostly rely on the inefficient and unreliable existing source of electricity from public-grid; they are more likely unable to finance the backup energy costs [26]. As a result, lack of electricity access is critical to the firm performance of small and medium-sized enterprises. These enterprises need to get new connections or finance the cost of backup energy to remain competitive and enhance production performance.

2.1. Labor Productivity and Access to Electricity

A measuring tool of firm performance, labor productivity, is a vital factor of economic development. It is closely connected to job creation and a major indicator of revenue generation, pointing out the perceived economic growth [5–27]. Although it is typically acknowledged that electricity access is a crucial pillar for enterprise performance. However, there are still enough disputes on how crucial electricity is and whether it can be treated as a mandatory or acceptable factor in firm performance and success. Access to electricity can positively impact firm performance, with electricity contributing to the incorporation of advanced equipment and enterprise activity [28]. Several pieces of literature conclude that access to electricity is one of the key factors of enterprise growth. An investigation between the linkage on investing in urban electrification and agricultural labor productivity reveals that electricity has played as the second biggest controlling factor on firm performance after the investment in R&D in Thailand [29]. Kaseke and Hosking [30] conducted their research in sub-Saharan Africa (SSA) discovered that inadequate electricity supply due to poor infrastructure quality decelerated firm performance in SSA. Moyo [31] also came out with a similar conclusion for SSA in the same year. He employs World Bank's Investment Climate Surveys data for the period between 2002 and 2005. Analyzing the cross-sectional data between 2001 and 2002 for six major capital cities in West Africa [28], found that several

obstacles hindered the perceived positive impact of access to electricity and slowed down firm performance. On the other hand, using panel data for the sample of 56 developing countries from 2001 to 2013 [32] and South African manufacturing firms observation over the 1997 to 2000 period [33], acknowledged the role of electricity generation assess that electricity has a positive and significant impact on labor productivity and total factor productivity. Due to rural electrification and extension project in Kenya, gross revenue per day and productivity per worked rise by up to 200% for small enterprises [33].

2.2. Firm Size and Labor Productivity

According to the findings made by Tovar et al. [34] for seventeen private Brazilian firms over 8 years, 1998–2005, it was noted that firm size contribute a significant effect on enhancing firms future productivity through the scale effect. Firouz [35] supports evidence of the positive role of firm size on labor productivity employing a cross-sectional regression model on data of 12,299 Iranian enterprise. Similarly, [14] examine the association between firm size and growth of labor productivity. This study employed a Canadian administrative dataset for 1984–1997 and discovered a affirmative association between firm size and labor productivity. However, the regression outcome from using both OLS and FGLS methods presented by [36] shows that firm size negatively affects labor productivity in Vietnamese SMEs in 1943. A similar negative result was also found by [37], who researched a survey of 3035 active Greek manufacturing firms in the years 1995 and 1999 [38,39] also reported a negative relationship between the structure of energy sources and SME firm performance. They concluded that employing internal energy generators to mitigate electricity needs to enhance firm performance, which sometimes is not economically viable for small and medium firms.

2.3. Electricity Access, Small and Medium-Sized Firms, and Labor Productivity

The importance of a reliable power supply to mitigate the hindrances of a poor electricity supply cannot be understated. Many firms in developing nations found a solution depending on the self-financed generator, which is more costly than public grid electricity. Remarkably, the cost of self-supported electricity is excessively high for small and medium firms, prohibit them from upgrading operations to enhance productivity [40,41]. According to [42], enterprises are classified from small to large firms not only concerning firm size. Power outages in the MENA region underline a negative impact on firms' performance, particularly labor productivity growth. The study employed perception-based measures technique, a negative impact of electricity constraints was reported to vary with firm size, especially more significant on small and medium firms. Using World Bank's Investment Climate Surveys data for 2002 and 2005 shows the association between energy infrastructure, indicated by the power outage and firm performance in sub-Saharan Africa. The outcome exhibits that poor infrastructural quality adversely affects firm productivity, with a more significant effect on SMEs [31]. In the context of the Senegalese economy [43], investigate the role of electricity constrained firms in firm productivity. A non-parametric approach based on data envelopment analysis (DEA) was applied for 528 Senegalese firms for the reference year 2011. The study showed that the relationship between a power outage and firm performance is positive and significant in terms of cost and technical efficiency scores for successful SMEs. However, it had an adverse effect on scale efficiency for power outage enterprises.

Nonetheless, large firms are often publicly enlisted and must comply with all financial standards that reflect better information integrity than small and medium firms that are poorly regulated. Further, large firms can influence more on regulatory authorities to gain more advantage in access to electricity [44,45]. The differences between SME and large firms in generating better information integrity affect their relative access to electricity.

3. Methodology

We employed World Bank Enterprise Survey's cross-sectional firm-level data for Bangladesh for which lack of access to electricity constraint data is available, including a total of 3196 sample firms over the period between 2007 and 2013. The survey data represents business perception on the biggest obstacles to firm performance and the relative significance of different constraints to firm productivity through extended interviews on manufacturing and service-oriented firms. It is important to mention that this survey is only conducted on formally registered firms, with a minimum of five employees, initially in the manufacturing and service industry. The most extensively used criterion in Bangladesh is the number of employees selected by WBES to distinguish small and medium-sized enterprises (SME). Table 1 exhibits the concise meaning of SMEs in Bangladesh [46].

Table 1. Definition of SMEs.

Firm Size	Number of Employees
Micro firms	Less than 10
Small firms	Less than 25
Medium Firms	Less than 250

Source: authors' creation according to European Union recommendation.

3.1. Data Analysis

Table A1 presents definitions of variables involved in this study. The analysis was pursued at both regional and national levels to explain potential differences by employing the WBES sample dataset of SMEs. The interlink was stated by the ordinary least squares (OLS) regression equation along with robust standard error to mitigate the possible effect of heteroscedasticity on the independent parameters:

$$\begin{aligned}\text{Labor Productivity} = {} & \beta 1 + \beta 2(\text{Electricity constraint}) + \beta 3(\text{Elecricity Obstacle}) + \beta 4(\text{Firm size}) + \\ & \beta 5(\text{Firm characteristics}) + \beta 6(\text{Owner characteristics}) + \beta 7(\text{Lack of access to electricity} * \text{SME Firm Size}) + \\ & \beta 8(\text{Elecricity Obstacle} * \text{SME Firm Size}) + \varepsilon,\end{aligned} \quad (1)$$

Next, we portray the variables employed in the paper.

3.2. Explained Variable: Labor Productivity

We select our explained variable, labor productivity, as an indicator of firm performance instead of total factor productivity (TFP) since TFP is particularly used as a residual, and hence, incline to measurement error. This study defined labor productivity as follows:

$$\text{Labor Productivity}_{it} = (\text{Employees}_{it} - \text{Employees}_{it-1})/(\text{Employees}_{it} + \text{Employees}_{it-1}), \quad (2)$$

3.3. Explanatory Variable

Lack of electricity access is classified as electricity constrained and electricity obstacle as explanatory variables to measure the output on firm performance via labor productivity. Firstly, we employ dummy variables "Apply to obtain for new Electrical Connection" to represent electricity-constrained SMEs due to inadequate power supply. The variables are individually coded as 0 if the firm did not apply for electrical connection. Similarly, it is separately denoted as one if the firm has successfully applied to obtain a new electrical connection to overcome the power shortage in the last fiscal year (WBES). We further added the SME entrepreneur's perception to electrical access as an obstacle. This obstacle dummy parameter is encoded separately as 0 if SME owners face moderate, major, or very severe obstacles to the present establishment activities, and 1 while owners experience electrical connection as no or minor obstacle to the enterprise's operations [47].

The firm's size is mentioned as the total employee numbers of each firm. As it is a more consistent and stable indicator across firms, employee numbers are chosen as alternative definitions of firm size [48,49]. So, we employ the number of employees to account for the

firm size. We also apply dummy variables for small and medium firms; coded as 1 and 0 for the other enterprises.

3.4. Control Variables

Consistent with prior theoretical frameworks, the proposed econometric model employed various control variables to achieve an unbiased estimator for independent variables effect, specifically denoting firms characteristics' [50–52]. The authors explained young SMEs lean to have more volatile than older counterparts and have a higher risk of exiting the market. They also exhibit firm age may generate a negative impact on labor productivity [53,54]. So, we control for firm age by regulating with a continuous log-transformed variable. The sector of operation must be controlled to ignore the models over determination issue. Hence, the use of a dummy variable to indicate whether firms are service or manufacturing (1 = service sector, 0 = other sectors, such as manufacturing). Again, proprietorship affects productivity in the long run, even though it is likely to have a negative impact on the short run [55]. Therefore, we choose proprietor ownership as a dummy control variable that marks the value of 1 for sole proprietorship and 0 for other ownership types. We also attempt to control the owner's years of managerial experience using a continuous and dichotomous variables to control female ownership [56].

3.5. Propensity Score Matching for Treatment Effect

Treatment effects permit the valuation of a causal treatment effect on an output employing sample data. We employ a matching technique to assess the treatment effects and develop a comparable observation of SMEs' along with access to electrical connection to signal possibility of selection bias and endogeneity; however, having similar remarked attributes relative to constrained firms'. The objective of matching untreated firms (apply for new electrical connection) and treated firms (no application for new electrical connection) is to create pairs according to specific remarkable samples. This kind of matching is preferable rather than random selection of comparison groups, as it is more likely to reduce bias by selecting small and medium firms with different traits [57,58].

Although matching approaches and regression both depend on contingent liberty for asserting causal effect, comparing does not depend on the kind of operational structure predictions usually employed in regressions. Furthermore, comparing specifically evaluate either each treated observable sample has available untreated observations for comparison. Recent economic study indicates that reducing selection bias in research according to sample statistical information probably obtained by averting operational structure and stating a general backup circumstances [59,60].

We applied the propensity score matching technique, recommending that the probability of receiving treatment complies with samples' specification. This technique is developed on obtaining treatment probability gained from probit regression, and it is subject to a series of notable features [61]. This methodology has also been employed in conservation and electricity consumption circumstances [62,63]. So, the propensity score is regarded as an benchmark feature that adds up a large number of observable characteristics that impact the treatment's likelihood (i.e., no application for electrical connection). Or, the PSM score signals a contingent likelihood of samples to be a segment of the treatment group and is noted by:

$$P(\mathrm{X}) = \Pr(T = 1|X)$$

The authors stated that conditioning separately on the propensity score, (Y_0, Y_1) $\perp T|P(X)$, under the estimation of conditional liberty (Y_0, Y_1) $\perp T|X$ can eliminate all biases due to observable features [64,65]. As writers exhibit, a familiar propensity might comprise comprehensive data regarding the consistency choices and optimal efficiency could be obtained by propensity score matching.

We assumed the average treatment effect on the treated (ATET) of electricity access via no application for new electrical connection and major obstacles on SME firm performance, measured by labor productivity. Average treatment effect on the treated (ATET) is the

deviation in mean outputs of the treated and untreated enterprise, where the untreated businesses is built comparing units according to propensity score. When calculating the average achievement for those who have received treatment, the ATET criteria are relevant [66,67]. Nonetheless, the likelihood of investigating two cells with precisely the equal value of propensity score incline to zero because the continuous variable propensity score attributes of the may not be enough to estimate the propensity score.

Several methods have been suggested to overcome this issue. Among them, the most applied methods are propensity score matching along with K-nearest neighbor matching and a caliper specification [68]. Outlining the caliper imposing a tolerance level on the maximum propensity score variances can eliminate bad matches, noted as a caliper. We employ a tolerance level with 0.05 caliper to specify that we only like to check an observation pair whether the absolute variance in propensity score matching is no more than 0.05 [5–69]. Even though the difference of the assumption enhances in conducting few matches, the benefit of small bias can be taken specifying the caliper. We also clearly stated that residuals for identically and independently allocated data are presented as the robust standard residuals for the projected ATET need feasible matches for treated and control contents [70,71].

Furthermore, prior studies show K-closest neighbor matching corresponds to K-nearest firms as a result of the propensity score. The parameter of K also enforce a balance between variance and bias, where a high value of K indicates small variance and large bias. We begin with the default option of 1 [72–74]. However, we also apply 3 as the inception for K, following the previous literature [73,74].

4. Results

We present the estimation results of regression in this section. Table 2 presents the descriptive statistics of independent, dependent, and control variables accompanied by the mean and standard deviation. The descriptive statistics show a positive average labor productivity growth of 0.262, with a standard deviation of 0.419. The average electricity constraint and electricity obstacle are positive at 0.141 and 0.116, with a standard deviation of 0.348 and 0.320, respectively. The close relation between the mean and standard deviation of electricity constraint and electricity obstacle reflects the impact on labor productivity. Additionally, the table shows 15% of service-oriented firms applied for new electrical connections due to electricity constrained in the businesses. The average firm size is 0.408, standing with a standard deviation of 0.492, which also depicts a close relation between mean and standard deviation. Firm age shows an average of 2.730 years with a standard deviation of 0.716, where the minimum is 0, and the maximum is 5.176 years.

Table 2. Summary of descriptive statistics.

Variables	N	Mean	SD	Min	Max
Labor Productivity	2850	0.262	0.419	−0.805	1
Electricity Constraint	3196	0.141	0.348	0	1
Electricity Obstacle	2922	0.116	0.320	0	4
Firm Size	3196	0.408	0.492	0	1
Firm Age	2914	2.730	0.716	0	5.176
Service Industry	3196	0.155	0.362	0	1
Proprietorship	3196	0.510	0.500	0	1
Managerial Experience	2907	16.88	10.02	0	60
Female Ownership	2922	0.182	0.386	0	1

Source: authors' calculation.

Table 3 shows labor productivity has a negatively insignificant correlation of −0.0144 with electricity constraint, but a negatively significant correlation of −0.0419 between electricity obstacles and labor productivity. This negative correlation means even for minor obstacles level, labor productivity decreases. Firm size and firm age strongly correlate with labor productivity, where the value is 0.223 and −0.181, respectively.

Table 3. Correlation matrix.

	Labor Productivity	Electricity Constraints	Electricity Obstacle	Firm Size	Firm Age	Service Industry	Proprietorship	Managerial Experience	Female Ownership
Labor Productivity	1								
Electricity Constraint	−0.0144	1							
Electricity Obstacle	−0.0419 *	0.0241	1						
Firm Size	0.223 ***	−0.0533 **	−0.0203	1					
Firm Age	−0.181 ***	−0.0464 *	0.00903	−0.0854 ***	1				
Service Industry	0.0662 ***	−0.0230	0.0619 ***	0.287 ***	−0.0000244	1			
Proprietorship	0.0471 *	−0.0263	0.0000438	0.385 ***	−0.0388 *	0.120 ***	1		
Managerial Experience	−0.203 ***	0.0235	0.0589 **	−0.105 ***	0.433 ***	−0.0171	−0.0596 **	1	
Female Ownership	−0.0640 ***	0.0428 *	0.0315	−0.285 ***	0.0576 **	−0.0908 ***	−0.439 ***	0.0929 ***	1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Source: authors' calculation.

We proceed to check the variance inflation factor (VIF) to ensure multi-collinearity does not exist between dependent and independent variables in Table 4. The table shows all VIF values are less than the cut-off values of 5, which indicates no significant multi-collinearity between explanatory and explained variables. So our model does not have a multi-collinearity issue.

Table 4. Detecting multicollinearity among variables using variance inflation factor (VIF).

Variables	Labor Productivity
Electricity Constraint	1.56
Electricity Obstacle	1.76
Firm Size	1.47
Electricity Constraints X SME Firm	1.59
Electricity Obstacle X SME Firm	1.88
Firm Age	1.27
Service Industry	1.09
Proprietorship	1.36
Managerial Experience	1.28
Female Ownership	1.27
Mean VIF	1.45

Source: authors' calculation.

We examined whether β1 is statistically significant from zero to test whether electricity-constraint and obstacles in the business arena significantly impact labor productivity. Table 5 exhibits regressions outcomes. Columns 1 and 2 represent models with either one of the independent variables of interest (electricity constraint and obstacle), and it shows only electricity obstacle is significantly negatively related to labor growth. This obstacle outcome is significant at the 10% significance level. However, due to the insignificant impact of electricity constraint on labor productivity, this outcome is similar to the finding of [75], which is electricity constraint turned out to be insignificant in developing countries. Therefore, we suggest that policies towards investment in infrastructure development may offset sunk costs from achieving revenue and eventually increase labor productivity. The table also indicates that firm age is negatively related to SME labor productivity. It shows that the service industry is positively significant at the 1% significance level as well. We further found SMEs' managerial experience is negatively significant to labor productivity. Other control variables such as proprietorship and female ownership have a statistically insignificant impact on labor productivity.

Table 5. Impact of access to electricity on labor productivity with interaction effect of firm size.

	(1)	(2)	(3)	(4)
Variables	**Labor Productivity**	**Labor Productivity**	**Labor Productivity**	**Labor Productivity**
Electricity Constraint	−0.0233		0.0520	
	(−0.721)		(1.327)	
Electricity Obstacle		−0.0450 *		0.0126
		(−1.881)		(0.406)
Firm Size			0.188 ***	0.195 ***
			(10.66)	(10.83)
Electricity Constraint X SME Firm Size			−0.173 ***	
			(−2.622)	
Electricity Obstacle X SME Firm Size				−0.119 **
				(−2.505)
Firm Age	−0.0727 ***	−0.0738 ***	−0.0694 ***	−0.0621 ***
	(−5.733)	(−5.959)	(−5.524)	(−5.152)
Service Industry	0.0627 ***	0.0705 ***	0.00850	0.0111
	(2.973)	(3.420)	(0.401)	(0.529)
Proprietorship	0.0110	0.0130	−0.0471***	−0.0439 **
	(0.636)	(0.749)	(−2.651)	(−2.478)
Managerial Experience	−0.00598 ***	−0.00579 ***	−0.00530 ***	−0.00578 ***
	(−6.878)	(−6.707)	(−6.185)	(−6.878)
Female Ownership	−0.0342	−0.0315	−0.00610	−0.00665
	(−1.537)	(−1.417)	(−0.279)	(−0.303)
Constant	0.554 ***	0.554 ***	0.483 ***	0.472 ***
	(16.25)	(16.52)	(14.08)	(14.01)
Observations	2799	2815	2786	2827
R-squared	0.057	0.059	0.095	0.097

t-statistics in parentheses | *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ |. Source: authors' calculation.

In addition, columns 3 and 4 show the findings between firm size and labor productivity. This outcome is positively significant at the 5% significance level and exhibits that firm size has a higher level of labor productivity [39]. Positive co-efficient also indicate that firms have more skilled labor that enhances firm performance.

To establish our third investigation, columns 3 and 4 also exhibit the interaction effect between SME firm size and access to electricity through applying for a new electrical connection due to power shortage. Our outcomes portray that SMEs that applied to obtain a new electrical connection have a significantly negative labor productivity. The outcome is significantly negative at 1% and 5% significance level for electricity constrained and electricity obstacle, respectively. The findings also exhibit evidence from the analysis that firm age and managerial experience are negatively significant at 1% level with the only difference of proprietor impact, which is negatively significant at 1% and 5% level. This emphasizes that the impact of those control variables on labor productivity is significant in the long run.

Propensity Score Matching

Table 6 depicts the treatment effects for average productivity of labor to all SMEs without application for new electricity connections and major electricity obstacles where the coefficient of the electricity constraint is approximately −0.017 and −0.040, respectively, the coefficient values are less than the average of if all SMEs had applied for new connection and had major obstacles. Without applying a new electricity connection and for major obstacles, the coefficients are insignificant in all other matching results. If SMEs had applied for a new connection and had enough access to the power grid, the result would come significant for labor productivity to SMEs' electricity constraints. Electricity obstacles related to intensity to obstacles in electricity for SMEs' labor productivity are negatively insignificant in PSM and in other matching results. These negative outcomes are statistically insignificant for both PSM methods employed, that is in line with our findings. The authors also presented

a regression on the matched sample, which was described as the observations in the treated group (no application for new connection and major obstacle) plus the observations in the control group that were matched to the treatment group after the matching.

Table 6. ATET estimates for access to electricity.

		PSM	PSM with Caliper	1-Nearest Neighbor	PSM 3-Nearest Neighbor
Electricity Constraint	ATET	−0.017 (−0.447)	−0.025186795 (−0.83)	−0.019900985 (−0.45)	−0.011773539 (−0.77)
	N	2834	2834	2834	2834
Electricity Obstacle	ATET	−0.040 (−1.286)	−0.041742631 (−1.84)	−0.01418459 (−0.44)	−0.023133686 (−0.87)
	N	2833	2833	2833	2833

Outcome variable: labor productivity. *t*-Statistics in parentheses in columns 1, 3, and 4. Standard errors for independent and identically distributed data in parentheses in column 2. Source: authors' calculation.

Table 7 summarizes the regression findings in the matched sample. The disparity between SMEs with no application for new electricity connection is statistically insignificant, and those with large or extreme electricity barriers are significant at a 10% significant level, respectively. Not surprisingly, a similar trend is discovered in our derived results, confirming the prior matching findings. In general, the derived outcomes present that the matching procedure is effective because the results are consistent between applying for a new electrical connection and not applying for a new connection and minor and major obstacles for the matched data samples. The treatment effects and PSM results are considered reliable from these observations since there is no significant difference for all treatment levels.

Table 7. Probit regression of the matched sample for access to electricity.

	(1)	(2)	(3)	(4)
	Propensity Matching	**Propensity Matching**	**Propensity Matching**	**Propensity Matching**
Variables	**Labor Productivity**	**Labor Productivity**	**Labor Productivity**	**Labor Productivity**
Electricity Constraint	−0.0243	−0.0233		
	(−0.734)	(−0.721)		
Electricity Obstacle			−0.0547 **	−0.0381
			(−2.226)	(−1.621)
Firm Size				0.182 ***
				(0.489)
Firm Age		−0.0727 ***		−0.0628 ***
		(−5.733)		(−5.206)
Service Industry		0.0627 ***		0.0103
		(2.973)		(0.489)
Proprietorship		0.0110		−0.0441 **
		(0.636)		(−2.488)
Managerial Experience		−0.00598 ***		−0.00572 ***
		(−6.878)		(−6.804)
Female Ownership		−0.0342		−0.00578
		(−1.537)		(−0.263)
Constant	0.264 ***	0.554 ***	0.269 ***	0.479 ***
	(32.27)	(16.25)	(32.12)	(14.25)
Observations	2799	2799	2827	2827
R-squared	0.000	0.057	0.002	0.095
F Stat	0.539	28.37	4.956	42.03

t-statistics in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: authors' calculation.

5. Discussions and Policy Implications

Consistent with previous researches, our article indicates that insufficient access to electricity due to even minor obstacles is a potential cause for poor labor productivity in

lower and middle-income nations [31,75,76]. However, the electricity constraint, denoted by applying for new electrical connection, is insignificant in our study. Our results regarding lack of electricity access and labor productivity are consistent with [77] in Uganda. Again, our analysis clearly demonstrates that minor obstacles could pose a significant negative impact on small firms' performance in Bangladesh. In 2008, Fernandes [78] also unveiled a similar result for lack of electricity access in Bangladeshi firms. This article highlights that other external factors hinder the positive effect of electrification on firm performance. These include bureaucratic environments, lack of investment in advanced technologies, limited knowledge on the sustainable energy source, and bribes for new connections, public infrastructure deficiencies, and frequency of corruption.

Furthermore, our findings confirm that labor productivity is positively significant with firm size, which indicates that these firms are running at the maximum productivity level. This finding is similar to prior studies, which also summarize the positive relationship between firm size and labor productivity [34,39,79]. These justify the significant positive impact of firm size on firm performance after controlling other variables.

Finally, our findings relate to SME firm size effect on the labor productivity for the electricity-constrained enterprise. Our result confirms that constrained SMEs were shown to lower productivity at a statistically significant level. Schiffer and Weder [45] argued that weak information integrity causes lower firm performance in electricity constrained SME firms. This result is consistent with our findings. Similarly [44], explained that small and medium firms rationed out of the electricity market might utter demand for a new electricity connection. Still, they might have inadequate access due to lack of information integrity, poor energy infrastructure, and insufficient external lending instrument. Due to electricity constraints [80], recommended that SMEs' should make self-finance investments for backup generators to enhance firm performance in sub-Saharan Africa. The finding derived has similarities to [42] on the impact of electricity-constrained SMEs' in firm performance in the case of Bangladesh. Our final findings tentatively suggest that production machine's inefficiency and unplanned workers distribution may cause lower firm performance for electricity-constrained SMEs' in Bangladesh.

Our empirical results have significant implications for policy formulations on Bangladeshi firms' performance. It infers that public-grid authority needs to introduce considerable policy changes, such as reformation of bureaucratic environment, infrastructural development on electricity generation to alleviate the probable negative effect on firm performance due to lack of electricity access. Existing regulations on labor and capital redistribution should be assessed carefully by policy-makers and pay more attention to the monitoring mechanism for better productivity, especially for electricity-constrained small and medium enterprises. Furthermore, the new policies should be implemented to enhance electricity production through an energy mix approach, public–private partnership projects, and renewable energy sources to ensure the firm's performance and sustainable development in Bangladesh.

6. Conclusions

Electricity access is considered a central pillar in enhancing SME labor productivity through numerous channels, such as improving infrastructural development, changes in national energy policy, implementing sustainable energy policy to promote more SMEs participation in national and regional level, especially in middle income countries. This article focuses on empirically examining the impact of electricity access in accelerating SME labor productivity in a cross-sectional firm level dataset for 3196 Bangladeshi firms over the period of 2007 to 2013.

This study explored the linkage between electricity constraints and firm size individual effect on firm performance. We have also examined whether small and medium-sized firms alleviate the impact of electricity constraints on firm performance. We have employed OLS model and the PSM techniques to empirically investigate the impact of the chosen variables on SME labor productivity. The outcomes of our empirical analysis posit that:

firm performance is partially significant to the lack of electricity access for minor obstacles. Additionally, our results establish a positive relationship between firm size and firm productivity. These outcomes unveil the energy constraints faced by small and medium-enterprises in the context of a developing economy.

Moreover, electricity-constrained SMEs have lower labor productivity due to inadequate power supply in most cases. The present research supplement the extant literature on access to electricity and the size of SMEs' inter-relation effects on firms' performance in the context of developing countries with limited energy resources. In addition, this study confirmed that ensuring sustainable electricity supply in SMEs can enhance labor productivity to gain a win-win scenario of industrial development and sustainable economic growth.

The primary limitation of this study is that it only considers SME firms' role in the relationship between electricity access and firm performance, without including other acclimation factors. For instance, firms with different sectors have differences in bank loan facilities, labor law, technology usage, customs and trade regulation, and risk preferences. Therefore, future research can be done by employing above mentioned adjustment factors as a control variable in the research model to prove whether these variables have a crucial effect. Another shortcoming of this article is that this study only explored the firm performance via labor productivity in Bangladesh, which may render the outcome unaffected for other developing countries. Future studies in this domain can incorporate this issue by broadening the methodology to include more South-Asian emerging economies. It would also be worthy of investigating whether the interaction effect of firm size and access to electricity varies among South-Asian countries. Moreover, considering the fact that developing countries have acute shortage of electricity [81], governments in developing countries should roll out plans to promote the use of renewable sources of energy [82,83] to fuel heightened economic activity. The use of clean energy will also help in environmental preservation, pollution abatement, and improved health outcomes in the society [84,85].

Nevertheless, it will be interesting for future studies to explore the role of corporate life cycle and executive characteristics in enhancing the performance of smaller firms [86–88]. Lastly, the unavailability of the latest survey data is another drawback of this research. Although this paper's existing available WBES survey data are plentiful to justify the research outcome, the latest addition in WBES data can still be included for future research.

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Appendix A

Table A1. Definition of Variables.

Variable	Definition	Source
Dependent Variables		
Labor Growth	Percentage growth of number of employees	WBES
Independent Variables		
Electricity Constraint	Dummy variable, equals to 1 if the firm applies for new electrical connection and 0 otherwise.	WBES
Electricity Obstacle	Dummy variable, equals to 1 if the firm face minor or no obstacle to the firm's operations and 0 otherwise.	WBES
Firm Size	Dummy variable, equals to 1 if the firm is small and medium and 0 otherwise.	WBES
Control Variables		
Firm Legal Status	Dummy variable, equals to 1 if firm is sole proprietorship and 0 otherwise.	WBES
Firm Sector Status	Dummy variable, equals to 1 if firm is service orientated and 0 otherwise.	WBES
Firm Ownership Status Female	Dummy variable, equals to 1 if firm owner is female and 0 otherwise.	WBES
Firm Age	Year of the survey—year of incorporation	WBES
Managerial Experience	Top manager's working experience (year)	WBES

Source: authors' creation.

References

1. Grimm, M.; Paffhausen, A.L. Do interventions targeted at micro-entrepreneurs and small and medium-sized firms create jobs? A systematic review of the evidence for low and middle income countries. *Labour Econ.* **2015**, *32*, 67–85. [CrossRef]
2. Blair, J.P.; Carroll, M.C. *Local Economic Development: Analysis, Practices, and Globalization*; SAGE Publications, Inc.: Thousand Oaks, CA, USA, 2009. [CrossRef]
3. Sullivan-Taylor, B.; Branicki, L. Creating resilient SMEs: Why one size might not fit all. *Int. J. Prod. Res.* **2011**, *49*, 5565–5579. [CrossRef]
4. Ayyagari, M.; Demirgüç-Kunt, A.; Maksimovic, V. Who creates jobs in developing countries? *Small Bus. Econ.* **2014**, *43*, 75–99. [CrossRef]
5. Motta, V. Lack of access to external finance and SME labor productivity: Does project quality matter? *Small Bus. Econ.* **2018**, *54*, 119–134. [CrossRef]
6. Van Ark, B.; O'Mahoney, M.; Timmer, M.P. The Productivity Gap between Europe and the United States: Trends and Causes. *J. Econ. Perspect.* **2008**, *22*, 25–44. [CrossRef]
7. Zhang, Y.-F.; Parker, D.; Kirkpatrick, C. Electricity sector reform in developing countries: An econometric assessment of the effects of privatization, competition and regulation. *J. Regul. Econ.* **2008**, *33*, 159–178. [CrossRef]
8. Wang, Z. *Constraints and Solutions for Energy and Electricity Development*; Springer: Singapore, 2019. [CrossRef]
9. Allcott, H.; Collard-Wexler, A.; O'Connell, S.D. How Do Electricity Shortages Affect Industry? Evidence from India. *Am. Econ. Rev.* **2016**, *106*, 587–624. [CrossRef]
10. Fisher-Vanden, K.; Mansur, E.T.; Wang, Q.J. Electricity shortages and firm productivity: Evidence from China's industrial firms. *J. Dev. Econ.* **2015**, *114*, 172–188. [CrossRef]
11. Piza, C.; Cravo, T.A.; Taylor, L.; Gonzalez, L.; Musse, I.; Furtado, I.; Sierra, A.C.; Abdelnour, S. The Impact of Business Support Services for Small and Medium Enterprises on Firm Performance in Low- and Middle-Income Countries: A Systematic Review. *Campbell Syst. Rev.* **2016**, *12*, 1–167. [CrossRef]
12. Mozas-Moral, A.; Moral-Pajares, E.; Viruel, M.J.M.; Bernal-Jurado, E. Manager's educational background and ICT use as antecedents of export decisions: A crisp set QCA analysis. *J. Bus. Res.* **2016**, *69*, 1333–1335. [CrossRef]
13. Bessonova, E.V.; Morozov, A.G.; Turdyeva, N.A.; Tsvetkova, A.N. Opportunities for accelerating labor productivity growth: The role of small and medium enterprises. *Vopr. Ekon.* **2020**, 98–114. [CrossRef]
14. Leung, D.; Meh, C.; Terajima, Y. *Firm Size and Productivity*; Bank of Canada: Ottawa, ON, Canada, 2008.

15. Rud, J.P. Electricity provision and industrial development: Evidence from India. *J. Dev. Econ.* **2012**, *97*, 352–367. [CrossRef]
16. Adenikinju, A.F. *Analysis of the Cost of Infrastructure Failures in a Developing Economy: The Case of the Electricity Sector in Nigeria*; CEAR: Ibadan, Nigeria, 2005.
17. Buckley, T.; Nicholas, S.; Ahmed, S.J. *Bangladesh Electricity Transition: A Diverse, Secure and Deflationary Way forward*; Institute for Energy Economics and Financial Analysis: Cleveland, OH, USA, 2016.
18. Khandker, A. Constraints and challenges of SME development in the developing countries: A case study of India, Pakistan and Bangladesh. *Int. J. SME Dev.* **2014**, *1*, 87–118.
19. Ahmed, F.; Haque, M. Constraints of Manufacture based Small and Medium Enterprise (SME) Development in Bangladesh. *J. Soc. Dev. Sci.* **2011**, *1*, 91–100. [CrossRef]
20. Haque, M.A.; Rahman, J. Power Crisis and Solution in Bangladesh. *Bangladesh J. Sci. Ind. Res.* **2010**, *45*, 155–162. [CrossRef]
21. Oseni, M.O.; Pollitt, M.G. A firm-level analysis of outage loss differentials and self-generation: Evidence from African business enterprises. *Energy Econ.* **2015**, *52*, 277–286. [CrossRef]
22. Abdisa, L.T. Power outages, economic cost, and firm performance: Evidence from Ethiopia. *Util. Policy* **2018**, *53*, 111–120. [CrossRef]
23. Adenikinju, A.F. Electric infrastructure failures in Nigeria: A survey-based analysis of the costs and adjustment responses. *Energy Policy* **2003**, *31*, 1519–1530. [CrossRef]
24. Steinbuks, J.; Foster, V. When do firms generate? Evidence on in-house electricity supply in Africa. *Energy Econ.* **2010**, *32*, 505–514. [CrossRef]
25. Din, H.T. *Light Manufacturing in Vietnam: Creating Jobs and Prosperity in a Middle-Income Economy*; The World Bank: Washington, DC, USA, 2014.
26. Pargal, S.; Banerjee, S.G. *More Power to India: The Challenge of Electricity Distribution*; The World Bank: Washington, DC, USA, 2014.
27. Harrison, A.; Lin, J.Y.; Xu, L.C. Explaining Africa's (Dis) advantage. *World Dev.* **2013**, *63*, 59–77. [CrossRef]
28. Grimm, M.; Hartwig, R.; Lay, J. Electricity Access and the Performance of Micro and Small Enterprises: Evidence from West Africa. *Eur. J. Dev. Res.* **2013**, *25*, 815–829. [CrossRef]
29. Fan, S.; Jitsuchon, S.; Methakunnavut, N. *The Importance of Public Investment for Reducing Rural Poverty in Middle-Income Countries: The Case of Thailand*; International Food Policy Research Institute: Washington, DC, USA, 2004.
30. Kaseke, N.; Hosking, S.G. Sub-Saharan Africa electricity supply inadequacy: Implications. *East. Afr. Soc. Sci. Res. Rev.* **2013**, *29*, 113–132. [CrossRef]
31. Moyo, B. Power infrastructure quality and manufacturing productivity in Africa: A firm level analysis. *Energy Policy* **2013**, *61*, 1063–1070. [CrossRef]
32. Alam, S.; Miah, M.D.; Hammoudeh, S.; Tiwari, A.K. The nexus between access to electricity and labour productivity in developing countries. *Energy Policy* **2018**, *122*, 715–726. [CrossRef]
33. Fedderke, J.; Bogetić, Ž. Infrastructure and Growth in South Africa: Direct and Indirect Productivity Impacts of 19 Infrastructure Measures. *World Dev.* **2009**, *37*, 1522–1539. [CrossRef]
34. Tovar, B.; Ramos-Real, F.J.; de Almeida, E.F. Firm size and productivity. Evidence from the electricity distribution industry in Brazil. *Energy Policy* **2011**, *39*, 826–833. [CrossRef]
35. Fallahi, F.; Sakineh, S.; Mehin Aslaninia, N. Determinants of labor productivity in Iran's manufacturing firms: With emphasis on labor education and training. In Proceedings of the International Conference On Applied Economics, Heraklion, Greece, 2–4 July 2020; pp. 169–178.
36. Ngoc, P.T.B.; Van Phuoc, N.H. Small and Medium Enterprises' Labor Productivity in Vietnam: A firm–level investigation. In Proceedings of the VEAM Conference, Ho Chi Minh City, Vietnam, 1–2 August 2017.
37. Papadogonas, T.; Voulgaris, F. Labor productivity growth in Greek manufacturing firms. *Oper. Res.* **2005**, *5*, 459–472. [CrossRef]
38. Peters, J.; Harsdorff, M.; Ziegler, F. Rural electrification: Accelerating impacts with complementary services. *Energy Sustain. Dev.* **2009**, *13*, 38–42. [CrossRef]
39. Lee, J.; Yu, J. Heterogenous Energy Consumption Behavior by Firm Size: Evidence from Korean Environmental Regulations. *Sustain.* **2019**, *11*, 3226. [CrossRef]
40. Foster, V.; Steinbuks, J. *Paying The Price For Unreliable Power Supplies: In-House Generation Of Electricity By Firms In Africa*; The World Bank: Washington, DC, USA, 2009.
41. Alby, P.; Dethier, J.-J.; Straub, S. Firms Operating under Electricity Constraints in Developing Countries. *World Bank Econ. Rev.* **2012**, *27*, 109–132. [CrossRef]
42. Fakih, A.; Ghazalian, P.; Ghazzawi, N. The Effects of Power Outages on the Performance of Manufacturing Firms in the MENA Region. *Rev. Middle East Econ. Finance* **2020**, *16*. [CrossRef]
43. Cissokho, L.; Seck, A. Electric power outages and the productivity of small and medium enterprises in Senegal. *Invest. Clim. Bus. Environ. Res. Fund Rep.* **2013**, *77*, 13.
44. Zehri, F.; Chouaibi, J. Adoption determinants of the International Accounting Standards IAS/IFRS by the developing countries. *J. Econ. Finance Adm. Sci.* **2013**, *18*, 56–62. [CrossRef]
45. Schiffer, M.; Weder, B. *Firm Size and the Business Environment: Worldwide Survey Results*; The World Bank: Washington, DC, USA, 2021.

46. European Union Recommendation, SME definition | Internal Market, Industry, Entrepreneurship and SMEs. 2003. Available online: https://ec.europa.eu/growth/smes/sme-definition_en (accessed on 13 September 2021).
47. Love, J.H.; Roper, S. SME innovation, exporting and growth: A review of existing evidence. *Int. Small Bus. J.* **2015**, *33*, 28–48. [CrossRef]
48. Uhlaner, L.M.; van Stel, A.; Duplat, V.; Zhou, H. Disentangling the effects of organizational capabilities, innovation and firm size on SME sales growth. *Small Bus. Econ.* **2013**, *41*, 581–607. [CrossRef]
49. Nur'ainy, R.; Nurcahyo, B.; Sri Kurniasih, A.; Sugiharti, B. Implementation of good corporate governance and its impact on corporate performance: The mediation role of firm size. *Glob. Bus. Manag. Res. Int. J.* **2013**, *5*, 91–104.
50. Becchetti, L.; Trovato, G. The Determinants of Growth for Small and Medium Sized Firms. The Role of the Availability of External Finance. *Small Bus. Econ.* **2002**, *19*, 291–306. [CrossRef]
51. Nichter, S.; Goldmark, L. Small Firm Growth in Developing Countries. *World Dev.* **2009**, *37*, 1453–1464. [CrossRef]
52. Söderbom, M.; Teal, F. *Firm Size and Human Capital as Determinants of Productivity and Earnings*; United Nations Industrial Development Organization: Geneva, Switzerland, 2001.
53. ACoad, A.; Segarra, A.; Teruel, M. Like milk or wine: Does firm performance improve with age? *Struct. Chang. Econ. Dyn.* **2013**, *24*, 173–189.
54. Cowling, M.; Liu, W.; Zhang, N. Did firm age, experience, and access to finance count? SME performance after the global financial crisis. *J. Evol. Econ.* **2018**, *28*, 77–100. [CrossRef]
55. De Kok, J.M.P.; Fris, P.; Brouwer, P. *On the Relationship between Firm Age and Productivity Growth—An Empirical Study into the Relationship between*; EIM Business and Policy Research Series: Zoetermeer, The Netherlands, 2006.
56. Aterido, R.; Hallward-Driemeier, M. Whose business is it anyway? *Small Bus. Econ.* **2011**, *37*, 443–464. [CrossRef]
57. Rideout, E.C.; Gray, D.O. Does Entrepreneurship Education Really Work? A Review and Methodological Critique of the Empirical Literature on the Effects of University-Based Entrepreneurship Education. *J. Small Bus. Manag.* **2013**, *51*, 329–351. [CrossRef]
58. Abadie, A.; Imbens, G.W. Bias-Corrected Matching Estimators for Average Treatment Effects. *J. Bus. Econ. Stat.* **2011**, *29*, 1–11. [CrossRef]
59. Dixit, P.; Dwivedi, L.K.; Ram, F. Strategies to Improve Child Immunization via Antenatal Care Visits in India: A Propensity Score Matching Analysis. *PLoS ONE* **2013**, *8*, e66175. [CrossRef] [PubMed]
60. Karhunen, H.; Huovari, J. R&D subsidies and productivity in SMEs. *Small Bus. Econ.* **2015**, *45*, 805–823.
61. Johnson, M.L.; Crown, W.; Martin, B.C.; Dormuth, C.R.; Siebert, U. Good Research Practices for Comparative Effectiveness Research: Analytic Methods to Improve Causal Inference from Nonrandomized Studies of Treatment Effects Using Secondary Data Sources: The ISPOR Good Research Practices for Retrospective Database Analysis Task Force Report—Part III. *Value Health* **2009**, *12*, 1062–1073.
62. Li, Z.; Cao, X. Analysis of Information Feedback on Residential Energy Conservation and the Implications: The Case of China. *Front. Environ. Sci.* **2021**, *9*, 12. [CrossRef]
63. Jensen, C.L.; Hansen, L.G.; Fjordbak, T.; Gudbjerg, E. Providing Free Autopoweroff Plugs: Measuring the Effect on Households' Electricity Consumption through a Field Experiment. *Energy J.* **2012**, *33*, 187–211. [CrossRef]
64. Durlauf, S.N. *Handbook of Social Economics*; Elsevier: Amsterdam, The Netherlands, 2011.
65. Rosenbaum, P.R.; Rubin, D.B. Reducing bias in observational studies using subclassification on the propensity score. *J. Am. Stat. Assoc.* **1984**, *79*, 516–524. [CrossRef]
66. Imbens, G.W.; Wooldridge, J.M. Recent Developments in the Econometrics of Program Evaluation. *J. Econ. Lit.* **2009**, *47*, 5–86. [CrossRef]
67. Stojčić, N.; Anić, I.-D.; Aralica, Z. Do firms in clusters perform better? Lessons from wood-processing industries in new EU member states. *For. Policy Econ.* **2019**, *109*, 102043. [CrossRef]
68. Caliendo, M.; Kopeinig, S. Some practical guidance for the implementation of propensity score matching. *J. Econ. Surv.* **2008**, *22*, 31–72. [CrossRef]
69. Caliendo, M.; Hujer, R.; Thomsen, S.L. The employment effects of job-creation schemes in Germany: A microeconometric evaluation. In *Advances in Econometrics*; Emerald Group Publishing: Bingley, UK, 2018; pp. 381–428. [CrossRef]
70. Abadie, A.; Imbens, G. Matching on the estimated propensity score. *Econometrica* **2016**, *84*, 781–807. [CrossRef]
71. Hofert, M.; Oldford, W. Visualizing dependence in high-dimensional data: An application to S&P 500 constituent data. *Econ. Stat.* **2018**, *8*, 161–183.
72. Murphy, F.; Miller, S. *Nonparametric Analysis in Accounting Research.*; University of Connecticut: Storrs, CT, USA, 2019. [CrossRef]
73. Eliasson, K.; Hansson, P.; Lindvert, M. Do firms learn by exporting or learn to export? Evidence from small and medium-sized enterprises. *Small Bus. Econ.* **2011**, *39*, 453–472. [CrossRef]
74. Kobayashi, Y. Effect of R&D tax credits for SMEs in Japan: A microeconometric analysis focused on liquidity constraints. *Small Bus. Econ.* **2014**, *42*, 311–327.
75. Wang, Y. What are the biggest obstacles to growth of SMEs in developing countries? – An empirical evidence from an enterprise survey. *Borsa Istanb. Rev.* **2016**, *16*, 167–176. [CrossRef]
76. Arnold, J.M.; Mattoo, A.; Narciso, G. Services inputs and firm productivity in Sub-Saharan Africa: Evidence from firm-level data. *J. Afr. Econ.* **2008**, *17*, 578–599. [CrossRef]

77. Neelsen, S.; Peters, J. Electricity usage in micro-enterprises — Evidence from Lake Victoria, Uganda. *Energy Sustain. Dev.* **2011**, *15*, 21–31. [CrossRef]
78. Fernandes, A.M. Firm Productivity in Bangladesh Manufacturing Industries. *World Dev.* **2008**, *36*, 1725–1744. [CrossRef]
79. Hsu, M.; Chen, B.-L. Labor productivity of small and large manufacturing firms: The case of Taiwan. *Contemp. Econ. Policy* **2000**, *18*, 270–283. [CrossRef]
80. Reinikka, R.; Svensson, J. Coping with poor public capital. *J. Dev. Econ.* **2002**, *69*, 51–69. [CrossRef]
81. Nduhuura, P.; Garschagen, M.; Zerga, A. Impacts of Electricity Outages in Urban Households in Developing Countries: A Case of Accra, Ghana. *Energies* **2021**, *14*, 3676. [CrossRef]
82. Ali, S.; Poulova, P.; Akbar, A.; Javed, H.M.U.; Danish, M. Determining the Influencing Factors in the Adoption of Solar Photovoltaic Technology in Pakistan: A Decomposed Technology Acceptance Model Approach. *Economies* **2020**, *8*, 108. [CrossRef]
83. Wang, Z.; Ali, S.; Akbar, A.; Rasool, F. Determining the Influencing Factors of Biogas Technology Adoption Intention in Pakistan: The Moderating Role of Social Media. *Int. J. Environ. Res. Public Health* **2020**, *17*, 2311. [CrossRef] [PubMed]
84. Akbar, A.; Alam Rehman, I.U.; Zeeshan, M.; Afridi, F.E.A. Unraveling the Dynamic Nexus Between Trade Liberalization, Energy Consumption, CO2 Emissions, and Health Expenditure in Southeast Asian Countries. *Risk Manag. Healthc. Policy* **2020**, *13*, 1915. [CrossRef] [PubMed]
85. Akbar, M.; Hussain, A.; Akbar, A.; Ullah, I. The dynamic association between healthcare spending, CO2 emissions, and human development index in OECD countries: Evidence from panel VAR model. *Environ. Dev. Sustain.* **2021**, *23*, 10470–10489. [CrossRef]
86. Ahmed, B.; Akbar, M.; Sabahat, T.; Ali, S.; Hussain, A.; Akbar, A.; Hongming, X. Does Firm Life Cycle Impact Corporate Investment Efficiency? *Sustainability* **2020**, *13*, 197. [CrossRef]
87. Hussain, A.; Akbar, M.; Khan, M.K.; Akbar, A.; Panait, M.; Voica, M.C. When Does Earnings Management Matter? Evidence across the Corporate Life Cycle for Non-Financial Chinese Listed Companies. *J. Risk Financ. Manag.* **2020**, *13*, 313. [CrossRef]
88. Akbar, A.; Jiang, X.; Fareed, Z.; Akbar, M. Does frequent leadership changes influence firm performance? Insights from China. *Econ. Bus. Lett.* **2021**, *10*, 291–298. [CrossRef]