

# The Productivity Cost of Power Outages for Manufacturing Small and Medium Enterprises in Senegal

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## Abstract

This paper investigates the productivity effects of power outages on manufacturing Small Scale Enterprises (SMEs) in Senegal, using a panel data on manufacturing firms. Productivity is estimated using stochastic frontier models, and power outages measured by their frequency or their duration. We controlled for firms owning a generator as well. The main results are drawn from random effects in a linear panel model. Nonetheless, the results remain consistent to the robustness checks using different models: a double-sided truncated data model and a generalized linear model, and different productivity measures: data envelopment analysis. We find that power outages have negative significant

effects on the productivity of SMEs; for example, the manufacturing sector lost up to around 11.6% of the actual productivity due to power outages in 2011, and small firms appear to be affected more than medium ones, 5% against 4.3%. Further, firms with a generator were successful in countering the adverse effect of power outages on productivity. Besides, another outstanding result is the significant positive effect of access to credit on productivity. At last, it appears that productivity increases with firms' size.

## Introduction

In the World Bank's Doing Business report (2017), Senegal ranks 147 out of a total of 190 countries for the ease of doing business index. On the index of "getting electricity", Senegal ranks even worse, that is 162, which only betters its "paying tax" index where it ranks 174. With the electricity "reliability of supply", for an index of zero to eight, Senegal scores zero. These performances of Senegal's economy take place amid many reforms the country carried out to improve the attractiveness of its business environment to investment. Yet, the country is not attracting lots of investment compared to other ECOWAS members such as Nigeria, Ghana and Cote d'Ivoire (African Development Bank, 2014; World Bank, 2016). This could be put on the other aspects of the country's business environment, among which the reliability of electricity supply.

Until 1960, production activities in Senegal were mostly private. In the late 1960s and early 1970s, however, sectors such as water and electricity were nationalized. In the case of electricity, the first step of the nationalization process covered the period 1972-1983, with the signing of a lease contract and the creation of a state-owned company, the Senegalese Electricity Company (SENELEC). Starting from 1983, SENELEC was holding a monopoly in the sector. In the mid-1990s, the sector went through many problems, and borne heavily on public finances, triggering strong suggestion from the World Bank and the International Monetary Fund toward the privatization of electricity in Senegal (Gökgür & Jones 2006). In fact, below target investment realization, combined with poor maintenance on a dilapidated generation facility led to a poor quality of service with an increasing number of power outages.

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1. In fact, the country has made four major reforms: increase transparency of information needed for property transactions, establishment of a new credit bureau, reduce profit tax rate and simplify tax compliance processes, introduce a new restructuring procedure to make insolvency easier to resolve (World Bank, 2016).
  2. ECOWAS: Economic Community of West African States composed of Benin, Burkina Faso, Cabo Verde, Cote d'Ivoire, The Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal and Togo.

The privatization process started effectively in December 1996; in March 1999, 34% of the shares of SENELEC were sold to Hydro-Quebec International and Elyo jointly. This first privatization of the electricity sector in Senegal lasted only 18 months. A new elected government in Senegal, in 2000, bought back the shares sold to Hydro-Quebec International and Elyo. In 2001, a second privatization process that weighs less on the bidding price and more on the technical and investment issues was launched, and most of the shares tendered (Commission de Régulation du Secteur de l'Electricité, Sénégal, 2007, 2011).

Electricity production in Senegal relies mostly on oil imports, because of an antiquated generation fleet. In fact, more than half of the machines age over ten years, and 80% of them function with fuel. Ninety per cent of the energy is from thermal generation, which impact highly on electricity production costs and price (Commission de Régulation du Secteur de l'Electricité, Sénégal 2007), that remains among the highest in the world. Part of the problem arises because the consumers participate barely in the financial stability of the company with a growing need for investment to update its fleet to face a demand growing at the rate of 8% a year. The government, on the other hand, in this midst insists on allocating huge subsidies to SENELEC, perpetuating a system that has so far failed to structure the company toward financial sustainability.

The lack of sufficient and adequate investment led to a very inefficient distribution network, saturated and dilapidated power grids that fails to meet the growing demand. The latter, coupled with a production deficit (distributed energy amounts to 32 MW in 2011 against 266 MW in 2010) and a low storage capacity and operating difficulties of the only refinery in the country, the African Refining Company (SAR), led to deterioration in the quality of service in 2011, with regular power cuts affecting the consumers, as well as producers. This environment has most likely affected firms' production activities, especially SMEs that consist of around 95% of total firms in Senegal.

SMEs are a major contributor to Senegal's national economy. They operate in growth supporting sectors such as construction (7%), commerce (33%), industries (15%) and other services (45%) (Cissokho & Seck, 2013). As a major source of wealth creation and employment, SMEs are an important factor of social integration and a powerful lever against poverty. In fact, SMEs account for over 40% of the total sales and 42% of jobs in the modern enterprises, for more than 20% of GDP, and for around 30% of domestic value added (Direction des PME, 2014). Since the early 2000s, however, SMEs are operating in an environment characterized by electrical power outages; as a matter of fact, 57% of them reported electricity as a major concern. SMEs sustained 26 outages on average in a typical month, each lasting on average around two hours (Cissokho & Seck, 2013).

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3. As of early 2017, SENELEC is still a public company.

The main objective of this research is to estimate the cost of power outages in terms of productivity loss to SMEs in Senegal. This objective is broken down in three specific objectives. First, we estimate firms' productivity using stochastic frontier analysis (SFA) (Greene, 2008; Kumbhakar & Lovell, 2000), and data envelopment analysis (DEA) (Coelli, 1996; Charnes et al., 1978; Wilson, 2008). Second, we model productivity as a function of power outages, firms' characteristics (size, age, gender, loans, etc.) and industry characteristics (sectors, etc.). And finally, we use the estimation results to compute the loss of productivity of SMEs due to power outages. The main problem in regression analysis remains the identification issue. In this instance, Senegal presents some characteristics that make this issue less problematic.

Senegal is one the most politically stable countries in West Africa (World Bank, 2017; Villalón, 2011). Therefore, the country has the advantage to focus resources and attention more on other aspects of political governance and business environment to foster growth and be on a sustained path toward emergence. This state makes Senegal an interesting case to analyse. In fact, in the last decade, most least developed countries (LDCs) in West Africa have experienced some political or social instability, triggering many unobservable factors that may interfere with firms' activities. The relative stability of Senegal makes the identification of the productivity effect of an unreliable electricity supply, in a West African LDC, less problematic compared to other countries with more unobservable influences in their business environment.

This paper contributes to the literature by analysing, in the case of Senegal, how the lack of reliability of a public service, specifically electricity in this case, could cost an LDC, particularly in West Africa, through its adverse effect on the productivity of manufacturing SMEs. We constructed an unbalanced panel data using firm level data of manufacturing (Cissokho & Seck, 2013; World Bank, 2007, 2014). The results point to a negative significant effects of power outage on productivity, which is in the same lines as Arnold et al. (2008) for sub-Sahara African economies and by Fisher-Vanden et al. (2015) in the case of China. Further with a loss amounting to around 11.6% of the actual productivity, 2011 stands out as the year firms were much affected.

## Methodology

Data for this study are from two main sources: a firm survey in 2012 that we conducted and the World Bank investment climate and business environment surveys (2007 and 2014) in Senegal. The 2012 survey is conducted late 2012 (Cissokho & Seck, 2013). The sample is drawn from a population of 6,000 firms from the national agency for statistics and demography (ANSD). We used a stratified sampling method, with respect to regions and sectors. The four regions considered cover more than 90% of firms in the

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4. We acknowledge the financial support of TrustAfrica and IRCDC in funding the survey.

country. The four sectors on the other hand are wholesale and retail, manufacturing, construction, and other services. For each stratum, firms are drawn randomly for a sample of 528 firms. SMEs are defined using the same criteria used in the World Bank surveys on industries in Senegal. The World Bank surveys are conducted around the world. Data is collected at the firm level and covered a broad range of issues related to the investment climate and business environment. Small firms have from five to 19 employees, medium firms from 20 to 99 employees and large ones have hundred and more employees (World Bank, 2007, 2014). The two data sets are combined in an unbalanced panel covering only manufacturing firms.

## Measuring productivity

Productivity is efficiency in production, that is, the output level obtained from a given quantity of inputs and typically expressed as an output–input ratio (Syverson, 2011). Methodologies developed to estimate total factor productivity can be put in two main groups: deterministic methods and stochastic methods. The first group simply assigns any deviation from ideal productivity to inefficiency. However, room can be made for shocks that can affect productivity without being under the control of the firm. Productivity in this paper is measured using stochastic frontier analysis (SFA). Other methods of computing productivity, Olley and Pakes (1996) and Levinsohn and Petrin (2003) cannot be used in this paper because of data limitations.

Any deviation from the ideal productivity, represented by the production frontier, could be deemed as coming from firms' inefficiency. In the SFA framework, however, some shocks from the economic environment, not under the control of firms, can affect productivity. In other words, deviations from the production frontier should not be entirely attributed to inefficiency, as part of it might be stochastic. Further, measurement errors are often an issue with production statistics, which also add onto the deviation from the production frontier. Consistent measures of productivity require thus considering these issues (Aigner et al., 1977; Meeusen & van den Broeck, 1977).

## Conclusion and policy implications

This paper investigates the productivity effect of power outages on SMEs in Senegal using an unbalanced panel on manufacturing firms. The political and social stability of Senegal makes identification issue of the net productivity cost of power outages less problematic. The main results are drawn from random effects in a linear panel model. Nonetheless, the results remain consistent to the robustness check we did using a double-sided truncated data model and a generalized linear model.

The results show that power outages have significant negative effects on firms' productivity. However, this effect is mitigated for firms owning a generator; in

fact, firms owning a generator avoided the loss due to power outages. Further, the results also point out that firms with access to credit are more productive than their counterparts. Further, the results also show that productivity tends to increase with firm size and the share of the principal owner. Some very important policy implications can be drawn from these outcomes, for the development of a competitive business environment and relevant policy supports for SMEs.

They suggest first that reforms should be undertaken to resolve the electricity problem. In fact, a more reliable electricity supply will help firms avoid the productivity loss it causes, making electricity less costly besides the relatively expensive monetary cost it born. Thus, it will contribute in making the business environment more attractive to investment. Further, solving the electricity outage problems would allow firms to save on the efforts and resources diverted to coping strategies. Moreover, in reducing uncertainty in the economic environment, a reliable power supply will put businesses in a more dynamic growth path since it will interfere less with investment and hiring decisions as states.

The second policy implication concerns improving businesses' access to credits and loans. Banks usually lend to promising businesses. The results show, however, that access to credits and loans promotes productivity. The government can in this matter work to facilitate the bank-firm relationship to facilitate firms' access to credits and loans. Besides, this policy implication would strengthen the effects from a reliable electricity service, giving businesses a greater growth opportunity.

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