

Overview

The code in this replication package reproduces the empirical and model results using Matlab, Stata, and Microsoft Excel. The raw data is from five sources (WES, World Bank, PWT, SMEDA, and Google surveys). Two main Matlab files calibrate the model and run all of the simulations. Additional files construct the empirical moments and produce the figures and tables in the paper. The replicator should expect the code to run for approximately 30 minutes.

Data Availability and Provenance Statements

The data used for Figures 7 and F.1 was from a survey of firms in Ghana and Nigeria conducted between June to August 2019. We used Google Surveys, a platform that allows users to survey a random sample of internet news readers. Survey participants were incentivized to participate in the survey by offering them a free access to the remainder of their news article after completing the survey. Participants are given the option of not partaking in the survey. Business owners were filtered by asking the participants about whether they currently owned and operated a business. Once a business owner has been identified, they are then asked between three and six further questions conditional on the survey. In total, we conducted 34 surveys involving 1,913 firms in Ghana and 1,512 firms in Nigeria given a total of 3425 surveyed firms. Around 14 percent dropped out after the initial screening question which gave a low dropout rate. We only analyzed the responses of participants who answered all questions.

Firm owners in both Ghana and Nigeria were asked a series of hypothetical questions about their expectations of what would happen if power outages were eliminated. Specifically, firm owners were asked how the elimination power outages will affect their profits, expansion through making new investments, expansion through hiring more workers, and the entry of new firms in the industry. For all questions we asked how likely the firms felt each outcome would be if power outages were eliminated, with the options being “very unlikely,” “unlikely,” “neutral,” “likely,” “very likely” and “I don’t know.”

To remedy the possibility of respondents providing uninformative answers or answers based on what they expect the surveyors would like to hear, we conducted another round of surveys that asked firms about the expected effects of a placebo “treatment” in which the national airports in Ghana or Nigeria convert to solar power. In all of the placebo surveys, we asked about exactly the same outcomes and used the exact same response options as the main surveys on power outages.

Statement about Rights

- I certify that the author(s) of the manuscript have legitimate access to and permission to use the data used in this manuscript.

Summary of Availability

- All data **are** publicly available.

Details on each Data Source

- Aggregate data from the World Enterprise Surveys (World Bank 2019a) were downloaded on 3/8/2020 from <https://www.enterprisesurveys.org/en/data/exploretopics/infrastructure>. The data from the infrastructure portion of the survey are included as part of this archive in /data/raw/ExportedResults.xlsx.
- Micro data from the World Enterprise Surveys (World Bank 2019a) were downloaded on 5/24/2021 from <https://login.enterprisesurveys.org/content/sites/financeandprivatesector/en/signin.html>. To download, the replicator must create a free account, agree to the confidentiality agreement, login, and select the relevant country from the dropdown menu. The replicator should download the following files and save them in the directory /data/raw with the specified file names below.
 - Micro survey data from Ghana: Ghana-2013-full-data.dta
 - Micro survey data from Nigeria: Nigeria-2012-full-data.dta
 - Micro survey data from Tanzania: Tanzania-2013-full-data.dta
 - Micro survey data from Uganda: Uganda-2013-full-data.dta
- Data on the GDP deflator (BEA 2019) were accessed from the Federal Reserve Bank of St. Louis, (FRED), <https://fred.stlouisfed.org/series/GDPDEF>. A copy of the data is included as part of this archive in /data/raw/GDPDEF.xlsx.
- Data on the pump price of diesel fuel (World Bank 2019b) was accessed from the world bank world development indicators databank, <https://databank.worldbank.org/source/world-development-indicators>. Use the dropdown menu to select pump price of diesel fuel from the list of available series. The series code is: EP.PMP.DESL.CD. A copy of the data is included as part of this archive in /data/raw/pump_price.xlsx.
- Data from the Penn World Tables 9.1 (DOI 10.15141/S50T0R) were downloaded from <https://www.rug.nl/ggdc/productivity/pwt/pwt-releases/pwt9.1?lang=en>. The data are included as part of this archive in /data/raw/pwt91.dta.
- Data on the Nigerian firm surveys were gathered from the 2017 National Survey of Small and Medium Enterprises (SMEDA 2017). The report can be downloaded from: [2017 Formal NEW in COREL DRAW CONVER.cdr \(smedan.gov.ng\)](#). The report from which the data are gathered is included as part of this archive in /data/raw/Nigeria_2017.pdf.
- Data on the effective price of grid electricity are from Figure 6 of Trimble et al. (2016). The report states that the underlying data are from World Bank staff calculations based on utility financial statements and other documents. The report can be downloaded from: [Financial viability of electricity sectors in Sub-Saharan Africa :](#)

[quasi-fiscal deficits and hidden costs \(worldbank.org\)](https://worldbank.org). The report from which the data are gathered is included as part of this archive in /data/raw/trimble_et_al.pdf

- Data on the impact of eliminating power outages (Figure 7) and outage frequencies (Figure F.1) were from google surveys conducted in Ghana and Nigeria as described above. The data are included as part of this archive in /data/raw/
 - First round main survey data from Ghana is included in this archive in /data/raw/ghana_main_survey_rawdata1.dta
 - Second round main survey data from Ghana is included in this archive in /data/raw/ghana_main_survey_rawdata2.dta
 - Third round main survey data from Ghana is included in this archive in /data/raw/ghana_main_survey_rawdata3.dta
 - Fourth round main survey data from Ghana is included in this archive in /data/raw/ghana_main_survey_rawdata4.dta
 - First round placebo ‘treatment’ survey data from Ghana is included in this archive in /data/raw/ghana_placebo_rawdata1.dta
 - Second round placebo ‘treatment’ survey data from Ghana is included in this archive in /data/raw/ghana_placebo_rawdata2.dta
 - Third round placebo ‘treatment’ survey data from Ghana is included in this archive in /data/raw/ghana_placebo_rawdata3.dta
 - Fourth round placebo ‘treatment’ survey data from Ghana is included in this archive in /data/raw/ghana_placebo_rawdata4.dta
 - First round main survey data from Nigeria is included in this archive in /data/raw/nigeria_main_survey_rawdata1.dta
 - Second round main survey data from Nigeria is included in this archive in /data/raw/nigeria_main_survey_rawdata2.dta
 - Third round main survey data from Nigeria is included in this archive in /data/raw/nigeria_main_survey_rawdata3.dta
 - Fourth round main survey data from Nigeria is included in this archive in /data/raw/nigeria_main_survey_rawdata4.dta
 - First round placebo ‘treatment’ survey data from Nigeria is included in this archive in /data/raw/nigeria_placebo_rawdata1.dta
 - Second round placebo ‘treatment’ survey data from Nigeria is included in this archive in /data/raw/nigeria_placebo_rawdata2.dta
 - Third round placebo ‘treatment’ survey data from Nigeria is included in this archive in /data/raw/nigeria_placebo_rawdata3.dta

- Fourth round placebo ‘treatment’ survey data from Nigeria is included in this archive in /data/raw/nigeria_placebo_rawdata4.dta

Dataset list

Raw data (all files are provided in /data/raw. All files except the data from our google surveys are from a publicly available source)

Data file	Source	Notes
ExportedResults.xls	WES	Infrastructure survey aggregates
GDPDEF.xlsx	FRED	
pump_price_diesel.xlsx	WBDI	Series: EP.PMP.DESL.CD
pwt91.dta	PWT	
Nigeria_2017.pdf	SMEDA	
Trimble_et_al.pdf	WB	
ghana_main_survey_rawdata1.dta	Google surveys	
ghana_main_survey_rawdata2.dta	Google surveys	
ghana_main_survey_rawdata3.dta	Google surveys	
ghana_main_survey_rawdata4.dta	Google surveys	
ghana_placebo_rawdata1.dta	Google surveys	
ghana_placebo_rawdata2.dta	Google surveys	
ghana_placebo_rawdata3.dta	Google surveys	
ghana_placebo_rawdata4.dta	Google surveys	
nigeria_main_survey_rawdata1.dta	Google surveys	
nigeria_main_survey_rawdata2.dta	Google surveys	
nigeria_main_survey_rawdata3.dta	Google surveys	
Nigeria_main_survey_rawdata4.dta	Google surveys	
nigeria_placebo_rawdata1.dta	Google surveys	
nigeria_placebo_rawdata2.dta	Google surveys	
nigeria_placebo_rawdata3.dta	Google surveys	
nigeria_placebo_rawdata4.dta	Google surveys	

Derived (all files are provided in data/derived and were created manually by the author)

Data file	Notes
country_codes.xlsx	Lists countries and their code
cross_country_moments.xlsx	Compiles empirical moments for each country into a single spreadsheet
ps_pg_generators.xlsx	Compiles data on the effective price of grid electricity, the average cost of grid electricity, and the percent of firms that have access to a generator into a single spreadsheet to be read into matlab.

Computational requirements

Software Requirements

- Stata (code was last run with version 17). The code requires the “fillmissing” package. To install, type `ssc install fillmissing`
- Matlab (code was last run with Matlab Release 2021b). The code requires the optimization toolbox.
- Microsoft Excel.

Memory and Runtime Requirements

Summary

Approximate time needed to process the raw data to on a standard (2020) 4 core laptop: 5 minutes.

Approximate time needed to calibrate the model for all of the alternative specifications and run all of the counterfactual simulations on a standard (2020) 4 core laptop: 30 minutes.

Details

The code was last run on a 4-core Windows 10 laptop with an 11th generation i7 processor and 32 GB of RAM.

Description of programs/code

Calculation of empirical targets

The programs can be run in any order to create the empirical targets use to calibrate the model and to process the data for Figure 3.

- Stata program `/data/programs/relative_gdp.do` uses the PWT 9.1 data to calculate the ratio of GDP in each country’s World Enterprise Survey year (2013) to GDP in

Nigeria's World Enterprise Survey year (2014). The program produces the file `/data/output/re1_gdp.xlsx`.

- Stata program `/data/programs/moments.do` processes the micro data from the World Enterprise surveys for Ghana, Nigeria, Tanzania, and Uganda to calculate three empirical targets (1) the fraction of firms that never experience an outages (2) the fraction of firms modern firms that experience an outage that have a generator and (3) the fraction of electricity that firms with a generator generate themselves. The program also calculates the semi-elasticity of generator ownership with respect to firm size for each country in the micro data. The program exports the values of each empirical target and the estimated semi-elasticity and confidence intervals to `/data/output/results_micro.xlsx`.
- Excel program `/data/programs/ac_mc.xlsx` computes the average cost and marginal cost of self-generated electricity and calculates the ratios of the average and marginal cost of self-generated electricity. The sheet "generator cost" computes the annualized capital cost of the generator. The data are used to calibrate the model and to produce Figure 3.
- Excel program `/data/programs/Nigeria_firms.xlsx` processes the data from SMEDA (2017) to produce the empirical targets fractions of modern workers and the fraction of modern firms in Nigeria.

Data cleaning for Figure 1, 7, and F.1

- Stata program `/data/figure1.do` merges WES data in `/data/raw/ExportedResults.xls` with GDP data from the PWT, in `/data/raw/pwt91.dta` to produce a spreadsheet with the processed data for Figure 1.
- Stata program `/data/ghana_firm_survey.do` cleans the raw data from the main and placebo 'treatment' surveys conducted in Ghana and save them. The program produces eight files in total; four from the main survey, one from each survey round and four from the placebo 'treatment' surveys, one from each survey round.
- Stata program `/data/Nigeria_firm_survey.do` cleans the raw data from the main and placebo 'treatment' surveys conducted in Nigeria. The program produces eight files in total; four from the main survey, one from each survey round and four from the placebo 'treatment' surveys, one from each survey round.

Empirical Figures

- Matlab program `/matlab_programs/sec_2_fig.m` produces Figures (1)-(3) of the paper.
- Stata program `/data/programs/survey_figures.do` produces the two graphics for Figure 7 as well as the graphic for Figure F.1.

Model calibration, model solution, figures, and tables

- Matlab program shell program `/matlab_programs/shell.m` calibrates the model, runs the counterfactual experiments and produces the tables and figures.
 - Matlab program `/matlab_programs/calibrate_shell.m` chooses the model parameters to minimize the distance between a set of model moments and their empirical targets. The code (1) runs the baseline calibration for Nigeria, (2) re-calibrates the model for each country, (3) re-calibrates the model for each sensitivity exercise in Table 6 and (4) re-calibrates the model for the extension with economies of scale in self-generation in Table E.1. The calibrations are stored with file names `cal_type` where type indicates the country and/or the particular robustness exercise.
 - Matlab program `/matlab_programs/calibrate.m` runs a Nelder-Mead algorithm to minimize the distance between the empirical and model values of the moments. The program is adapted to Matlab from Numerical Recipes routine `amoeba` (Press et al. 1988, page 411).
 - Matlab programs `/matlab_programs/nelder.m` and `/matlab_programs/nelder2.m` perform the reflections, contractions and expansion portions of the Nelder-Mead algorithm. The programs are adapted to Matlab from Numerical Recipes routines `amotry` (Press et al. 1988, pg 411).
- Matlab program `/matlab_programs/steady_states.m` computes the initial and no-outages steady state for every calibration of the model. It decomposes the gains in output per worker between the initial and no-outages steady states into the short-run partial-equilibrium effect, the firm expansion channel, and the firm entry channel. It computes the raw data for the weak links and tax experiments in Appendix E. It calculates the capital and productivity decomposition in Appendix E.
 - Program `/matlab_programs/solveModel.m` computes the model equilibrium conditions, aggregate variables, moments, and elasticity of generator ownership with respect for firm size, given a value of the wage and the probability of grid power.
 - Program `/matlab_programs/errors_ss.m` calculates the labor market clearing condition and the rationed grid electricity market clearing condition for a given value of the wage and probability of grid power. It outputs the model values of the moments for the calibration.
 - Program `/matlab_programs/errors_noentry.m` calculates the labor market clearing condition and the grid electricity market clearing condition for a given value of the wage, price of grid

electricity and probability of grid power, when the distribution of entrepreneurs is fixed at its value in the initial steady state.

- Program `/matlab_programs/errors_sspg.m` calculates the labor market clearing condition and the grid electricity market clearing condition for a given value of the wage, price of grid electricity, and probability of grid power.
- Program `/matlab_programs/errors_sspg_tax.m` calculates the labor market clearing condition and the grid electricity market clearing condition for a given value of the wage, price of grid electricity, and probability of grid power, when there is a tax on electricity producers, τ .
- Matlab program `/matlab_programs/figures.m` produces Figure 4 – 6 in the main paper and Figures E.1 and E.2 in the Appendix.
 - Matlab program `/matlab_programs/findzstar.m` reports the difference in profits between the modern and traditional sectors for a firm with productivity z^* in the analytic version of the model from Section 3 of the paper.
- Matlab program `/matlab_programs/tables.m` produces the tables in the paper and in the Appendix.

Instructions to Replicators

The archive has the file structure necessary to run the code, including the empty folders: `/data/output`, `/data/temp`, `/figures` and `/tables`.

To replicate calibration targets and the empirical semi-elasticity of firm size with respect to generator ownership.

1. Run the programs from the folder containing the full replication archive. All file paths are relative to this folder.
2. Calculate empirical targets. These programs can be run in any order.
 - a. Run `/data/programs/re1_gdp.do` to calculate GDP per capita relative to Nigeria.
 - b. Run `/data/programs/moments.do` to calculate the fraction of firms that experience outages that have a generator, the fraction of modern firms that do not experience outages, and the fraction of electricity that firms with generators produce themselves.
 - c. Run `/data/programs/Nigerian_firms.xlsx` to calculate the fractions of firms and workers in the modern and traditional sectors in Nigeria.

- d. Run `/data/programs/ac_mc.xlsx` to calculate the ratios of the average and marginal cost of self-generated electricity to grid electricity in each country.
3. Produce Figures 1-3. Run the programs in the following order.
 - a. Run `/data/programs/figure1.do` to process the raw data for Figure 1.
 - b. Run `/data/programs/sec_2_figs.m` to produce Figures 1-3.
4. Run `/data/programs/moments.do` to calculate the empirical semi-elasticity of generator ownership with respect to firm size.
5. To calibrate the model, computer the counterfactual experiments, and calculate results for Tables 1-6, C.1-C.4, D.1, E.1 and E.2 and Figures 6, E.1 and E.2. Run `/matlab_programs/shell.m`.
6. Produce Figures 7 and F.1. Run the programs in the following order.
 - a. Run `/data/programs/ghana_firm_survey.do` to process the raw data files for Ghana.
 - b. Run `/data/programs/nigeria_firm_survey.do` to process the raw data files for Nigeria.
 - c. Run `/data/programs/survey_figures.do` to produce Figure F.1 and panels A and B of Figure 7.

List of tables and programs

The provided code reproduces all numbers, tables, and figures in the paper.

Figure/Table	Program	Line Number	Output file
Table 1	<code>matlab_programs /tables.m</code>	16	<code>direct.tex</code>
Table 2	<code>matlab_programs/tables.m</code>	38	<code>mom.tex</code>
Table 3	<code>matlab_programs/tables.m</code>	57	<code>elasticity.tex</code>
Table 4	<code>matlab_programs/tables.m</code>	93	<code>Kg_pg.tex</code>
Table 5	<code>matlab_programs/tables.m</code>	123	<code>agg.tex</code>
Table 6	<code>matlab_programs/tables.m</code>	181	<code>sensitivity.tex</code>
Table C.1	<code>matlab_programs/tables.m</code>	260	<code>model_fit.tex</code>
Table C.2	<code>matlab_programs/tables.m</code>	295	<code>cal_matrix.tex</code>
Table C.3	<code>matlab_programs/tables.m</code>	324	<code>country_moments.tex</code>
Table C.4	<code>matlab_programs/tables.m</code>	360	<code>country_params.tex</code>
Table C.5	<code>data/programs/ac_mc.xlsx</code>		
Table D.1	<code>matlab_programs/tables.m</code>	388	<code>agg_initial.tex</code>

Table E.1	matlab_programs/tables.m	415	generator_fixed_cost.tex
Table E.2	matlab_programs/tables.m	460	decomp2.tex
Figure 1	data/programs/sec_2_figs.m	14	fig1.eps
Figure 2	data/programs/sec_2_figs.m	41	fig2.eps
Figure 3	data/programs/sec_2_figs.m	64	fig3.eps
Figure 4	matlab_programs/figures.m	93	model_graph2b.eps
Figure 5	matlab_programs/figures.m	131	model_graph3.eps
Figure 6	matlab_programs/figures.m	175	decomp.eps
Figure 7	data/programs/survey_figures.do	66-73	fig8_ghana.pdf & fig8_nigeria.pdf
Figure E.1	matlab_programs/figures.m	207	weak_y.eps, weak_k.eps
Figure E.2	matlab_programs/figures.m	242	tax_y.eps, tax_k.eps
Figure F.1	data/programs/survey_figures.do	31-33	outagesfreq.pdf

References

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