JDEff appendix for The Effects of Market-based Reforms on Access to Electricity in Developing Countries: A Systematic Review

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Note: The material contained herein is supplementary to the article named in the title and published in the Journal of Development Effectiveness (JDEff).

# Appendix A. Sources consulted

Table A 1: List of databases consulted

|  |
| --- |
| **Database** |
| ABI/INFORM Global |
| British Library for Development Studies |
| Business Source Complete |
| Econlit |
| Energy Citation Database |
| Google Scholar |
| PAIS International |
| World Wide Political Science Abstracts |

Table A 2: List of websites consulted

|  |  |
| --- | --- |
| **Organisation** | **Website** |
| 3ie Impact Evaluation database | www.3ieimpact.org/evidence/impact-evaluations |
| 3ie Systematic Reviews database | www.3ieimpact.org/evidence/systematic-reviews |
| African Development Bank  | www.afdb.org |
| Asian Development Bank | www.adb.org |
| Australian Aid Agency | www.ausaid.gov.au |
| Canadian International Development Agency | www.acdi-cida.gc.ca |
| Danish Development Agency | www.um.dk |
| Department for International Development | www.dfid.gov.org |
| European Commission |  ec.europa.eu/index\_en |
| European Environment Agency (EEA) Datasets  | www.eea.europa.eu/publications |
| Gesellschaft für International Zusammenarbeit (GIZ) | www.giz.de |
| Inter-American Development Bank  | www.iadb.org |
| Intergovernmental Panel on Climate Change (IPCC) Data Distribution Centre | www.ipcc-data.org |
| Japan International Cooperation Agency and Japan Bank for international Cooperation | www.jica.go.jp/english |
| Kreditanstalt für Wiederaufbau (KfW) | www.kfw.de/Internationale-Finanzierung |
| Swedish development agency | www.sida.org |
| The World Bank + Office of Evaluation and Development | www.worldbank.org |
| UN: UNICEF UNEP UNDP UN-HABITAT | www.un.org |
| US Agency for International Development | www.usaid.gov |

# Appendix B. Search results

Figure A 1: Search result flow diagram

First-stage screening of titles

First stage with publication date later than 1980:

15179

* Participants (P)
* Interventions (I)
* Outcomes (O)
* no theoretical modelling

Excluded in first-stage screening or for being duplicates:

11650

Excluded in second-stage screening:

3049

Descriptions of interventions: 1750

Book or Paper review:

 29

Not available: 45

Country: 476

Intervention: 701

Non-applied research:

 48 40

Back referencing:

23

Citation tracking:

6

Primary search:

3529

Second-stage screening of abstracts

Potentially relevant studies:

3558

* P, I , O
* qualitative vs. quantitative evidence

Simulation: 31

Satisfaction survey: 6

No differentiation by infrastructure sector: 4

Efficiency analysis: 28

Before-after, without control: 7

other: 11

Third-stage screening of abstracts and full texts

Qualitative evidence studies:

395

Quantitative evidence studies:

114

* P, I , O
* Comparisons
* Study designs

Excluded in third-stage screening:

87

Excluded in third-stage screening:

352

Mechanisms: 74

Quality: 12

Focus: 180

Included quantitative evidence studies:

27

Previous or ongoing reforms: 86

Included qualitative evidence studies:

43

Table A 3: Study-level summary of included quantitative evidence studies

| **Study** | **Location** | **Type of Reform/ Intervention** | **Number of Waves** | **Sample Size** | **Unit of Analysis** | **Method of Analysis** | **Outcome Type** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Alcázar et al. (2007) | Latin America (Peru, rural) | Privatisation | 1 | 2671 | Household | Propensity Score Matching | Electricity price and/ or tariffHousehold welfareQuality |
| Andres et al. (2009) | Latin America and Caribbean(19 countries) | Private Sector InvolvementRegulation | 11 | 2000 | Utility | Fixed Effects  | SupplyElectricity price and/ or tariffElectricity generation costsInefficienciesRevenue or price and cost ratiosQuality |
| Balza et al. (2013) | Latin America (18 countries) | Private Sector InvolvementRegulation | 40 | 684 | Country | Fixed Effects  | SupplyElectricity price and/ or tariffInefficiency |
| Cubbin & Stern (2006) | Cross-Regions(28 countries) | Privatisation Competition-enhancing pol.Regulation | 22 | 585 | Country | Fixed Effects  | Supply |
| Du et al. (2013) | Asia (China) | Unbundling  | 2 | 2093 | Utility | Difference-in-Differences | Technical efficiency |
| Du et al. (2009) | Asia (China) | Independent Power Producers | 2 | 2161 | Power Plant | Difference-in-Differences + IV | InefficiencyNumber of employees |
| Erdogdu (2011*a*) | Cross-Regions(31 develop­ing countries) | PrivatisationUnbundling Wholesale electr. marketCompetition-enhancing pol.Independent Power Prod.Regulation | 28 | 1049 | Country | Fixed and Random Effects | Revenue or price and cost ratiosIndustrial and residential price ratio |
| Erdogdu (2011*b*) | Cross-Regions(60 develop­ing countries) | Composite reform | 27 | 2046 | Country | Fixed and Random Effects | SupplyInefficienciesTechnical efficiency |
| Estache & Rossi (2005) | Latin America (14 countries) | PrivatisationRegulation | 8 | 535 | Utility | Fixed Effects and OLS  | Number of employees |
| Gao & Van Biesebroeck (2014) | Asia (China) | Unbundling  | 10 | 10792 | Utility | Difference- in-Differences + IV | Electricity generation costsNumber of employees |
| Gonzalez-Eiras & Rossi (2008) | Latin America (Argentina) | Private Sector Involvement | 11 | 24432 (Household)242 (Provinces) | Household and Subcountry Region (Provinces) | Difference-in-Differences and Probit | Household welfare |
| Guasch et al. (2006) | Latin America (10 countries) | Privatisation | Not Available | 823 | Utility | Fixed Effects  | SupplyElectricity price and / or tariffInefficienciesNumber of employeesQuality |
| Khan (2014) | Asia (Pakistan) | Privatisation | 6 | 356 | Power Plant  | OLS | Electricity generation costs |
| Koo et al. (2012) | Cross-Regions(35 developing countries) | Private Sector InvolvementRegulation | 11 | 385 | Country | Random and Fixed Effects  | Inefficiency |
| Malik et al. (2015) | Asia (India) | Unbundling | 22 | 478 (Power Plants)4298 (Electricity Generating Unit) | Power Plant and Electricity Generating Unit | Difference-in-Differences | InefficiencyTechnical efficiency |
| Nagayama (2010) | Cross-Regions (86 countries) | PrivatisationUnbundling Wholesale electr. marketCompetition-enhancing pol.Independent Power Prod.Regulation  | 22 | 1652 | Country | Fixed Effects  | Supply Inefficiencies |
| Nagayama (2009) | Cross-Regions (78 countries) | Composite reform | 19 | 1006 | Country | Fixed and Random Effects + IV | Electricity price and / or tariff |
| Nagayama (2007) | Cross-Regions (83 countries) | PrivatisationUnbundling Wholesale electr. marketCompetition-enhancing pol.Independent Power Prod.Regulation | 18 | 915 | Country | Fixed and Random Effects  | Electricity price and/ or tariff |
| Panda (2002) | Asia (India) | PrivatisationUnbundling | 13 | 756(Utilities)156 (State Electricity Boards) | Utility and Subcountry Region (State Electricity Boards) | Fixed and Random Effects  | Electricity price and/or tariffElectricity generation costsInefficienciesTechnical efficiencyNumber of employeesRevenue or price and cost ratios |
| Pargal (2003) | Latin America (9 countries) | Private Sector InvolvementRegulation | 19 | 693 | Country; Other (Infrastructure Sector x Country) | Fixed Effects  | Investment |
| Sen & Jamasb (2012) | Asia (India) | PrivatisationUnbundlingCompetition-enhancing pol.Independent Power Prod.Regulation | 17 | 245 | Subcountry Region (States) | Fixed Effects  | Electricity price and/or tariffInefficienciesTechnical efficiencyIndustrial and residential price ratio |
| Urpelainen et al. (2018) | Cross-Regions (181 countries) | Composite reform | 27 | 4310 | Country | Fixed and Random Effects + IV | SupplyInefficiencies |
| Vagliasindi & Besant-Jones (2013) | Cross-Regions (22 countries) | PrivatisationUnbundling Private Sector InvolvementRegulation | 21 | 271 | Country | Fixed and Random Effects and GEE | SupplyElectricity price and / or tariff |
| Wren-Lewis (2015) | Latin America and Caribbean (18 countries) | PrivatisationRegulation | 13 | 1359 | Utility | Fixed Effects  | Number of employees |
| Yu & Pollitt (2009) | Cross-Regions (69 countries) | Composite reform | 10 | 120 | Country | Random Effects  | Quality |
| Zhang et al. (2008) | Cross-Regions (36 develop­ing and transitional countries) | Private Sector InvolvementRegulation | 19 | 638 | Country | Fixed Effects  | Supply |
| Zhang (2005) | Cross-Regions (25 developing countries) | PrivatisationCompetition-enhancing pol.Regulation | 17 | 374 | Country | Fixed Effects  | Supply |

# Appendix C. Outcome measures

Table A 4: Outcomes included in this review

| **Outcome type** |  | **Detailed outcome variables collected (examples)** |
| --- | --- | --- |
| Intermediate (secondary) outcomes: |  |  |
| Technical and financial efficiency or inefficiency  |  |  |
| * utilities
 |  | Overall productivity (per customer)Fuel productivity (ln)Labour productivity (ln) |
| * generation
 |  | Capacity utilisation, i.e. the ratio of electricity generation to average capacityPlant load factor, i.e. the ratio of a power plant’s actual to its potential output according to its nameplate capacityPlant availability, i.e. the share of hours in a given time period a power plant was available for generationOperating heat rate (ln), i.e. the sum of energy carriers burned per kWh multiplied by the their heating value |
| * transmission and distribution
 |  | Transmission and Distribution losses (% of total electricity generated) |
| Labour force |  | Number of employees (in ln terms, per 1000 customers or per MkWh sold) |
| Investment |  | Real Private Investment |
| Supply |  | (Net) electricity generation (per capita or per employee\*)Electricity generation capacity (per capita)No. of electricity connections (in ln terms or per employee\*)Electricity sold (per year in ln terms, per year and employee\*) |
| Quality |  | Duration of interruptionsFrequency of interruptions |
| Costs |  | Unit cost of production (per kWh)Intermediate input expenditures |
| Tariffs  |  | Average residential or industrial or overall electricity price |
| Price ratios |  | Industrial-residential price ratio |
| Revenue |  | Price-cost ratio |
| Primary (final) outcome: |  |  |
| Electricity access (supply) |  | (Rural) electricity access rates (% of population or households) |
| Household welfare |  | Birth rate proportion less than 2500 grams |

*Note:* All measures are differentiated between the household level, the community or municipality level, and other levels of analysis such as the utility, system, grid, region, or country. A few studies additionally used industrial/ residential price ratios and cross-subsidization as outcomes. Due to their limited number and since these outcomes poorly serve as performance measures, I abstained from showing related results. \* These per-employee supply indicators have all been included in the Supply category even though it has to be borne in mind that they may as well be affected by system efficiency.

# Appendix D: Calculation and pooling of effect sizes

***D.1 Effect size calculation***

Effect sizes were calculated for each estimation *i* imported from the included studies. *βi* is defined as the *i*th treatment effect. It can either refer to the coefficient of the treatment variable in regression-based studies or, for matched-based strategies, to the difference in the mean outcome in the treatment group and comparison group, -. The standardized mean differences (SMD) as the key effect size measure is then given by *SMD*i = *βi*/*si*, with being the standard deviation of the respective outcome variable at endline (post-treatment).

Due to data availability, I had to rely on different standard deviations , where *i* refers to each individual estimation imported from the included studies, *j* to the respective sample with *j*={Control, Treatment, Pooled} and *t* to the point in time where data has been retrieved, with *t*={baseline, endline}. The generally preferred standard deviation is the pooled post-treatment standard deviation of the outcome variable (Waddington et al. 2012). It is based on the treatment and control group standard deviations as defined by Hedges (1981) for matched-based studies and the standard deviation of the error term in the regression for regression-based studies.

Table A 5: Standard deviations of outcome variable used for effect size calculation

| **Hierarchy** | **symbol** |  | **Description of type of standard deviation (sd)** | **reference** |
| --- | --- | --- | --- | --- |
|  |  |  | pooled post-treatment sd | Hedges (1981) |
|  |  |  | sd of the error term | Keef & Roberts (2004) |
|  |  |  | sd of the post-treatment control group | Glass (1976) |
|  |  |  | total post-treatment standard deviation | - |
|  |  |  | total cross-panel standard deviation | - |
|  |  |  | total pre-treatment standard deviation | - |
|  |  |  | Borenstein approximation of pooled sd  | based on Borenstein et al. (2009*a*, 22) |
|  |  |  | total cross-panel standard deviation on the log-transformed scale | based on Higgins et al. (2008, 6075) |

Alternative standard deviations used in this review are – in order of preference – the following (see also Table A 5): first, the standard deviation of the post-treatment control group (Glass 1976). As an approximation of this standard deviation, I use, second, the total post-treatment standard deviation , third, the total cross-panel standard deviation or, fourth, the total pre-treatment standard deviation , in particular for panel data, which lacks the differentiation between treatment and control. Through information on the dates of reform implementation, subsample sizes for treatment and control and can, however, be approximated. These can then be plugged into equation 4.3 of Borenstein (2009*a*) that can be transformed to, fifth, yet another approximation of the pooled standard deviation , which is technically only applicable for bivariate effect sizes. *ti* in this equation is the Student *t*-statistic of the estimated coefficient *βi*. Finally, there are several papers with treatment effects in log-transformed scale, for which the total cross-panel standard deviation on the log-transformed scale can be approximated based on Higgins et al. (2008, 6075) with and being the squared standard deviation (i.e. variance) and mean of the raw outcome measurement, respectively.

The standard error *SE* of *SMD*i is the second main standardized measure to be calculated. It was approximated by *SE*(*SMD*)i = *SMD*i/𝑡i, where *ti* is the Student *t*-statistic of the estimated *β* coefficient.

***D.2 Hierarchisation of estimations for contributing to pooled effect estimates***

Relevant study characteristics that potentially required hierarchisation of estimations for the pooling of effect estimates were identified in three steps:

*Step 1*: If same intervention sub-type, same outcome, or same sample were assessed in multiple estimations per article, I checked the applied definitions, methods, and specifications along the priority criteria listed in Table A 6.

Table A 6: First set of priority criteria adopted for the pooling of effect estimates

|  |  |
| --- | --- |
| **preference could be established** | **no priority** |
| PCa1 | standard definition of intervention variable > alternative definition | PCb1 | equally appropriate intervention vari­ables for same Intervention Sub-Type |
| PCa2 | average effects > heterogeneous effects/ particular subgroup/ sensitivity analysis > robustness checks  | PCb2 | equally appropriate methods |
| PCa3 | power sector estimations > cross-sector estimations (e.g. including telecommunication) | PCb3 | equally appropriate estimators |
| PCa4 | IV > non-IV or vice versa, depending on the appropriateness of the IV | PCb4 | equally appropriate sets of controls |
| PCa5 | fixed effects panel > OLS |  |  |
| PCa6 | fixed effects panel > random effects panel or vice versa, depending on the tests and assessment conducted by the original authors |  |  |
| PCa7 | without interaction term > with interaction term |  |  |
| PCa8 | with controls > without controls  |  |  |
| PCa9 | estimations excluding a few strong outliers (as determined by authors) > estimations including the strong outliers |  |  |
| PCa10 | only one aggregate intervention variable per Intervention Sub-Type > multiple intervention variables per Intervention Sub-Type |  |  |

*Step 2*: A few estimations selected in Step 1 included multiple variables of the same intervention type or sub-type (e.g. a privatisation transition period dummy and a privatisation post-transition dummy in Guasch et al. 2006). I decided to include all estimates in the pooling if the individual variables added up to the likely effect of the intervention type or sub-type as a whole (e.g. minority and majority privatisation in Cubbin and Stern 2006). Conversely, I excluded the complete estimation in the synthesis of the respective intervention type, if it included various sub-types of the same intervention type that, in sum, do not necessarily reflect the likely effect of the intervention type as a whole (e.g. *wholesale electricity market* and *unbundling* as sub-types of *liberalisation* in Erdogdu 2011*a*). The latter implied the exclusion of estimations with multiple variables of the intervention types *liberalisation* and *regulation* (see Table A 7).

Table A 7: Second set of priority criteria adopted for the pooling of effect estimates

|  |  |
| --- | --- |
| **preference could be established** | **no priority** |
| PCa11 | exclusion of estimations with multiple intervention variables per Intervention Type or Sub-Type for the for the Intervention Types *Liberalisation* and *Regulation* and their Sub-Types (if no aggregate intervention variable per Intervention Type or Sub-Type, respectively; cf. PCa10)  | PCb5 | inclusion of all estimates from estimations with multiple intervention variables per Intervention Type or Sub-Type for the for the Intervention Types *Privatisation, Private Sector Involvement* and *Composite Reform* (if no aggregate intervention variable per Intervention Type; cf. PCa10)  |

*Step 3*: The estimations selected in Step 1 and 2 were then aggregated along the three dimensions intervention, outcome, and sample as outlined in Table A 8.

Table A 8: Depiction of approach adopted to pool effect estimates

|  |  |  |  |
| --- | --- | --- | --- |
| **Pooling** | **Intervention** | **Outcome** | **Unit of observation in sample** |
| Level at which effects are estimated in estimations selected in Step 1 and 2 | Intervention Sub-Type (e.g. unbundling) | Individual Outcome(e.g. Residential electricity access) | Any unit of observation (e.g. Latin America) |
|  aggregation | *no priority* | *no priority* *(alternatively: most standard outcome selected)* | *if countries: highest aggregated geographic area selected* |
| Default used for pooling effect sizes | Intervention Type (e.g. Privatisation) | Outcome Type(e.g. Supply and Investment) | Analysis at highest aggregated geographic level |
|  aggregation | - | *no priority*  | - |
| Pooled effect sizes used for sensitivity analysis, meta-regressions and publication bias assessment | Intervention Type | No differentiation by Outcome Type | Analysis at highest aggregated geographic level |

Subgroup analysis of main Intervention sub-type, main outcomes, and continents used the information shown in the table above on the disaggregated level and the aggregation approaches as outlined in Table A 9.

Table A 9: Summary of pooling of effect estimates for subgroup analysis

|  |  |  |  |
| --- | --- | --- | --- |
| **Pooling for Subgroup analysis** | **Intervention** | **Outcome** | **Unit of observation in sample** |
| … of main Intervention Sub-Type (e.g. unbundling) | *Intervention Sub-Type*  | No differentiation by Outcome Type | Analysis at highest aggregated geographic level |
| … of main Outcomes (e.g. Residential electricity access) | Intervention Type | *Individual Outcome* | Analysis at highest aggregated geographic level |
| … of Continents (e.g. Latin America) | Intervention Type | No differentiation by Outcome Type | *Any unit of observation* |

*Note:* The cells in italic highlight the dimension that has been changed for the purpose of the respective Subgroup analysis.

***D.3 Synthetic effect sizes***

To test whether results are affected by this potentially arbitrary hierarchisation process, I additionally calculated “synthetic effect sizes”. These synthetic effect sizes are meant to reflect the average effect size of the eligible study estimates that accounts for the dependence of the estimates coming from the same study. Borenstein et al. (2009*a*, chapter 24) suggest the sample-weighted average of the *m* estimates as single synthetic effect size point estimate of :

and a formula that can be transformed to yield a “synthetic standard error” of the effect size:

.

 in this formula is the correlation coefficient between effect size estimates. This is unknown and can hardly be plausibly approximated for the included studies. I therefore assume =1, i.e. perfect correlation, since this is the most conservative option given that precision will likely be underestimated (with variance likely overestimated).

***References not included in main article***

Glass, G. (1976). Primary, Secondary, and Meta-analysis of Research. *Educational Researcher*, *5*, 3-8.

Hedges, L. V. (1981). Distribution Theory for Glass’s Estimator of Effect Size and Related Estimators. *Journal of Educational Statistics*, *6*, 107-128.

Higgins, J. P. T., White, I. R., & Anzures-Cabrera J. (2008). Meta-analysis of Skewed Data: Combining Results Reported on Log-transformed or Raw Scales. *Statistics in Medicine* 27: 6072–6092. doi: 10.1002/sim.3427.

Waddington, H., White, H., Snilstveit, B., Hombrados, J. G., Vojtkova, M., Davies, P., Bhavsar, A., Eyers, J., Perez Koehlmoos, T., Petticrew, M., Valentine, J. C., & Tugwell P. (2012). How to Do a Good Systematic Review of Effects in International Development: A Tool Kit. *Journal of Development Effectiveness*, *4*(3), 359-387. doi: 10.1080/19439342.2012.711765.

# Appendix E: Quantitative evidence results for additional outcomes

The main article summarizes estimated effect sizes in the form of forest plots only if the respective combinaton of intervention type and outcome type is studied by at least three articles. Separate for each of the four intervention types, Table A 10 reproduces the same data as the forest plots for the other outcome types together with main outcomes assessed in the primary studies, such as *transmission and distribution losses* and the *number of employees* of the outcome type *efficiency*.

In addition, it shows the *p*-value indicating whether the effect size is significantly different from zero and the Tau-squared test statistic as another heterogeneity measure. It indicates the between-study variance of effect sizes across studies in a random-effects meta-analysis. As such, it is an absolute measure of heterogeneity measured in the unit of the outcome and thus has to be interpreted in its size with reference to the outcome.

Table A 10: Additional effect size results

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Effect Size** |  | **Heterogeneity tests** |
|  | **SMD** | **95% confidence interval** | ***p*-value** (ES=0) |  | **Tau-sq** | **I-sq** | ***p*-value** (chi-sq) | **Sample size** |
| **Privatisation** |  |  |  |  |  |  |  |  |  |
| **Other Outcome Types** |  |  |  |  |  |  |  |  |  |
| Labour force | -0.37 | -0.59 | -0.16 | 0.00 |  | 0.02 | 92% | 0.00 | 2 |
| Quality | 0.20 | -0.14 | 0.55 | 0.24 |  | 0.06 | 97% | 0.00 | 2 |
| Household welfare | -0.04 | -0.12 | 0.04 | 0.32 |  | - | - | - | 1 |
| **Main Outcomes** |  |  |  |  |  |  |  |  |  |
| Transmission and Distribution losses (%) | 0.03 | -0.25 | 0.30 | 0.85 |  | 0.05 | 93 | 0.00 | 3 |
| Number of employees | -0.37 | -0.59 | -0.16 | 0.00 |  | 0.02 | 92 | 0.00 | 2 |
| Electricity gen. capacity p. cap. | 0.09 | 0.02 | 0.17 | 0.01 |  | 0.00 | 0 | 0.99 | 2 |
| (Net) electricity generation p.cap. | -0.03 | -0.26 | 0.20 | 0.79 |  | - | - | - | 1 |
| (Residential) electricity price | -0.07 | -0.12 | -0.02 | 0.01 |  | 0.00 | 0 | 0.89 | 4 |
| Residential electricity access (%) | 0.33 | 0.30 | 0.36 | 0.00 |  | - | - | - | 1 |
|  |  |  |  |  |  |  |  |  |  |
| **Liberalisation** |  |  |  |  |  |  |  |  |  |
| **Other Outcome Types** |  |  |  |  |  |  |  |  |  |
| Labour force | 0.07 | -0.21 | 0.35 | 0.63 |  | 0.03 | 66% | 0.09 | 2 |
| Supply & investment | 0.19 | -0.04 | 0.43 | 0.10 |  | 0.02 | 67% | 0.08 | 2 |
| Quality | - | - | - | - |  | - | - | - | - |
| Price & costs | -0.05 | -0.09 | -0.01 | 0.02 |  | 0.00 | 0% | 0.38 | 2 |
| Household welfare | - | - | - | - |  | - | - | - | - |
| **Main Outcomes** |  |  |  |  |  |  |  |  |  |
| Transmission and Distribution losses (%) | - | - | - | - |  | - | - | - | - |
| Number of employees | -0.03 | -0.07 | 0.01 | 0.12 |  | - | - | - | 1 |
| Electricity gen. capacity p. cap. | 0.30 | 0.11 | 0.48 | 0.00 |  | - | - | - | 1 |
| (Net) electricity generation p.cap. | 0.05 | -0.18 | 0.29 | 0.66 |  | - | - | - | 1 |
| (Residential) electricity price | - | - | - | - |  | - | - | - | - |
| Residential electricity access (%) | - | - | - | - |  | - | - | - | - |
|  |  |  |  |  |  |  |  |  |  |
| **Private Sector Involvement** |  |  |  |  |  |  |  |  |  |
| **Other Outcome Types** |  |  |  |  |  |  |  |  |  |
| Labour force | -0.19 | -0.32 | -0.06 | 0.00 |  | - | - | - | 1 |
| Quality | 0.19 | 0.13 | 0.24 | 0.00 |  | - | - | - | 1 |
| Household welfare | 0.03 | -0.22 | 0.28 | 0.80 |  | - | - | - | 1 |
| **Main Outcomes** |  |  |  |  |  |  |  |  |  |
| Transmission and Distribution losses (%) | -0.07 | -0.19 | 0.06 | 0.31 |  | 0.02 | 88% | 0.00 | 5 |
| Number of employees | -0.19 | -0.32 | -0.06 | 0.00 |  | - | - | - | 1 |
| Electricity gen. capacity p. cap. | 0.10 | 0.00 | 0.20 | 0.06 |  | - | - | - | 1 |
| (Net) electricity generation p.cap. | 0.00 | 0.00 | 0.00 | 0.72 |  | - | - | - | 1 |
| (Residential) electricity price | -0.02 | -0.10 | 0.06 | 0.65 |  | 0.00 | 43% | 0.15 | 4 |
| Residential electricity access (%) | 0.35 | -0.37 | 1.06 | 0.34 |  | 0.26 | 99% | 0.00 | 2 |
|  |  |  |  |  |  |  |  |  |  |
| **Regulation** |  |  |  |  |  |  |  |  |  |
| **Other Outcome Types** |  |  |  |  |  |  |  |  |  |
| Labour force | 0.00 | -0.12 | 0.12 | 0.95 |  | - | - | - | 1 |
| Quality | 0.25 | 0.19 | 0.32 | 0.00 |  | - | - | - | 1 |
| Household welfare | - | - | - | - |  | - | - | - | - |
| **Main Outcomes** |  |  |  |  |  |  |  |  |  |
| Transmission and Distribution losses (%) | 0.08 | -0.08 | 0.25 | 0.34 |  | 0.03 | 96% | 0.00 | 4 |
| Number of employees | 0.00 | -0.12 | 0.12 | 0.95 |  | - | - | - | 1 |
| Electricity gen. capacity p. cap. | 0.19 | 0.02 | 0.36 | 0.03 |  | 0.01 | 84% | 0.01 | 2 |
| (Net) electricity generation p.cap. | -0.01 | -0.02 | 0.00 | 0.16 |  | 0.00 | 0% | 0.47 | 2 |
| (Residential) electricity price | 0.10 | -0.21 | 0.42 | 0.52 |  | 0.08 | 96% | 0.00 | 3 |
| Residential electricity access (%) | 0.19 | -0.17 | 0.54 | 0.30 |  | 0.06 | 96% | 0.00 | 2 |

Among others, this table is informed by three quantitative evidence studies that did not contribute to effect sizes presented in the main article. These are:

* Gao and van Biesebroeck (2014): *Labour force* and *Efficiency* (transmission and distribution losses) related to liberalisation;
* Gonzalez-Eiras and Rossi (2008): *Household welfare* related to private sector involvement;
* Wren-Lewis (2015): *Labour force* related to privatisation and regulation.

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# Appendix F. Discussion of electricity policy drivers of reform impacts

The following summarizes discussions in the qualitative literature regarding the four identified electricity policy drivers of reform drivers, namely (i) a commercial approach, (ii) competitive arrangements, (iii) cost-reflective pricing, and (iv) independent, empowered and efficient regulation. The discussion is organized along the structure of Table 5 in the main text. Countries or continents are referred to for illustrative purposes only. Some examples may not represent the current status quo but rather explain certain mechanisms from a historic perspective:

* a *commercial approach* that properly establishes commercial corporate governance structures including decision-making and accountability. In Table 5 in the main text, it is located at the intersection of *privatisation* and *private sector involvement* on the one hand and Efficiency and Labour force on the other. The prevalence of non-commercial practises has been found in the early years of electricity sector reforms in Pakistan and India, for example (Malik et al. 2009; Nair 2008). They go along with low billing and collection efficiencies and high technical and commercial losses, in particular. The transition to commercial entities has to account for the social welfare functions previously fulfilled by the electricity utilities to mitigate disruptive negative effects on certain consumer segments (Karekezi and Kimani 2002). For certain functions, this may be achieved through regulatory measures, e.g. with regards to disconnection and pricing policies.
* *cost-reflective pricing* remains “at the heart of the success or failure” of reforms (Jamasb et al. 2017). It mainly relates to the Outcome Price and Costs and the intervention types *liberalisation* and *regulation* (Table 5 in the main text). As compared to actual costs, Han et al. (2005), for example, find that from a social welfare perspective prices in China tended to be too low for central government owned utilities and too high or regional or foreign invested ones. Determining and – at least in an early reform phase – regulating cost-reflective tariff structures, however, is an economically and technically complex and not always straightforward task (Meher and Sahu 2013). Eberhard et al. (2011) further stress that insufficient cost recovery is not only a function of low tariffs but also of high costs. This implies that measures to increase cost recovery should always be accompanied by regulatory measures to incentivize cost-minimization. Finally, the question of adequate price signals extends to transmission network expansion and use. In Latin America, disputes regularly arose among market players about the appropriate allocation of transmission payments (Rudnick and Zolezzi 2001). Increases in prices obviously have negative effects on household welfare by lowering disposable incomes. Whether these effects are regressive in nature, i.e. affecting poorer segments stronger than richer ones, depends largely on prevailing electrification rates. In Sub-Saharan Africa with mostly low electrification rates, this has therefore been found to be less an issue than in Latin America (Karekezi and Kimani 2002; Kozulj and Di Sbroiavacca 2004).
* *competitive arrangements* that yield a functioning electricity market with a sufficient number of players. They primarily link the intervention types *private sector involvement*, *liberalisation*, and *regulation* with the outcomes *efficiency* and *labour force* (Table 5 in the main text). According to Von der Fehr and Millán (2003), economic, technological and institutional conditions have to be conducive to competitive outcomes, which can be qualified based on the reviewed literature as follows:
	+ economic conditions: On the one hand, the investment climate needs to be sufficiently favourable to attract private interest in the first place, an issue that particularly caused severe problems in implementing electricity sector reforms in Sub-Saharan African countries (Haanyika 2006; Malgas and Eberhard 2011; Babatunde 2011).[[1]](#footnote-1) Notable factors are general country-specific expropriation risks and renegotiation risks related to regulatory contracts (Murillo and Finchelstein 2004; Pollitt 2004). Not least, this also involves cost-reflective pricing devoid of entrenched subsidies (Kodwani 2009). On the other hand, the size of the market is a critical factor. Liberalisation interventions, notably unbundling and wholesale electricity markets, are more difficult to install in small electricity systems, where they may rather lead to low-competition oligopolistic market structures (Nepal and Jamasb 2012).
	+ technological conditions: the main primary energy sources have to be competitive, since monopolists can otherwise extract all rents from downstream activities (Estache and Rodriguez-Pardina 2000). Nepal and Jamasb (2012) give the example of Nepal, where large hydropower determines a high minimum efficient scale of power generation that leaves the market with few competitors. Additionally, the initial technological endowment of the electricity sector plays a relatively strong role given the more pronounced path dependency of electricity infrastructure systems. Finally, the technical infrastructure (e.g. load dispatch centres) may simply create constraints to the sourcing from different electricity suppliers (Kodwani 2009).
	+ institutional conditions: the literature first of all highlights the need to address the full range of competition areas, which also requires institutional coordination between regulatory and competition policies. Beyond head-to-head competition, this comprises market and yardstick competition, including competitive tendering for monopoly concessions, mergers and acquisitions in regulated sectors, competitive advocacy, and clear third-party access regulation (Estache and Rodriguez-Pardina 2000; Greco et al. 2011). In Argentina, for example, the obligation of all new public transmission investments above $2 million to be competitively tendered led to significantly reduced construction costs (Pollitt 2008). The early reform process in Chile missed restrictions on ownership concentration. In consequence, the electricity sector remained a highly oligopolistic, vertically integrated industry acting in a very imperfect competitive context (Gabriele 2004). Room for discriminatory third-party network access and its adverse effects were observed in Nepal (Nepal and Jamasb 2012).

As noted by Gabriele (2004), the maximum achievable degree of competition considering these various challenges remains limited for most developing countries. As a consequence, efficiency gains achieved through sector reforms in some Latin American countries have not necessarily reached the consumers but remained within the mono- or oligopolies (Rudnick and Zolezzi (2001). In any case, the opening of the electricity sector to competition is best implemented in a coordinated and step-wise approach, in which competitive arrangements are progressively introduced in the generation, wholesale and retail level, respectively (Nepal and Jamasb 2015, Figure 1). Joskow (2008) adds that such arrangements proofed to be preferably dealt with structurally ex ante rather than ex post.

* more broadly speaking about regulatory oversight, the literature stresses the importance of *independent, empowered and efficient regulation*. The lack of autonomy and professional expertise has been stressed in the case of Pakistan (Malik et al. 2009). More fundamentally, Kayo (2002) stressed the lack of an enabling legal and regulatory framework related to stalling electricity sector reforms in Zimbabwe; Karekezi and Kimani (2002) observed some reluctance to establish independent regulatory agencies in various African countries. Similarly, Pineau (2005; 2007) determined the absence of transparency and accountability mechanisms as one of twelve policy incoherencies in the Cameroonian electricity reforms around the year 2000. Nair (2008) further pointed out that even if the necessary powers and enforcing instruments are in place, the state of the sector that is regulated may inhibit the application of these instruments. He gives the example of India, where the regulator was largely seized with regulating ‘negativities’, i.e. supply shortages, revenue deficits of utilities and technical and commercial losses.

While this discussion focuses on the electricity sector, Songvilay et al. (2017) also make clear based on the example of Laos that electricity sector reforms are best embedded within wider mutually reinforcing economic reforms covering law, fiscal matters, macroeconomic stabilization, and public sector capacity building.

This synthesis underscores that the mechanisms mostly link the interventions with intermediate outcomes. Table 5 in the main text mentions another separate channel through which households may benefit from privatisation reforms: privatisation proceeds to the government – either from the transfer of ownership to private operators or for the concession of electricity services – may be reinvested for social purposes (Rosillo-Calle et al. 2002). Other authors like Kozulj and Di Sbroiavacca (2004) point out that indirect impacts of energy sector reforms may affect household welfare even stronger than these direct effects. They hold electricity sector reforms responsible for increased foreign indebtedness, monetary appreciation, growing unemployment and ultimately higher poverty levels in Latin America. Such statements, however, lack sufficient evidence.

1. Kapika and Eberhard (2013) present examples of countries like Kenya and Uganda that – despite these challenges – managed to introduce significant capacity from independent power producers in their electricity systems. [↑](#footnote-ref-1)