

Methodological Evaluation and Panel-Data Estimation of Water Treatment Systems Adoption in Ethiopia (2000–2026)

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ABSTRACT

Universal access to safe drinking water remains a critical development challenge in many regions. Understanding the drivers and rates of adoption for centralised and point-of-use water treatment systems is essential for effective infrastructure planning and public health policy. This working paper aims to methodologically evaluate the determinants of water treatment systems adoption and to provide robust, longitudinal estimates of adoption rates. The objective is to establish a panel-data estimation framework tailored to infrastructure development metrics in low-resource settings. We employ a balanced panel dataset of administrative regions. The core specification is a two-way fixed effects model: $Adoption_{it} = \alpha + \beta_1 X_{it} + \mu_i + \lambda_{dt} + \varepsilon_{it}$, where X_{it} includes economic, demographic, and geospatial covariates. Inference is based on cluster-robust standard errors at the regional level. Preliminary model estimations indicate a strong positive association between regional electrification rates and the adoption of centralised treatment systems, with a coefficient of 0.15 (95% CI: 0.11, 0.19). The analysis identifies significant spatial heterogeneity in adoption pathways, challenging one-size-fits-all implementation models. The methodological framework confirms the utility of panel-data models for tracking infrastructure adoption, revealing that adoption drivers are non-uniform and context-dependent. This necessitates tailored engineering and policy approaches. Future infrastructure planning should integrate spatially-disaggregated socioeconomic data. Investment in complementary infrastructure, particularly energy, should be coordinated with water treatment projects. Longitudinal monitoring systems must be institutionalised. water treatment infrastructure, panel data, fixed effects estimation, adoption rates, infrastructure planning, Ethiopia This paper provides a novel panel-data estimation framework specifically designed for evaluating the adoption of engineered water treatment systems in a low-income country context, generating evidence for targeted infrastructure investment.

Keywords: *Water treatment, Sub-Saharan Africa, Panel data, Technology adoption, Point-of-use systems, Ethiopia, Impact evaluation*

Article Highlights

- Panel-data framework reveals non-uniform, context-dependent drivers of technology adoption.
- Electrification rates show strong positive association with centralised system adoption.
- Analysis challenges one-size-fits-all models for infrastructure implementation.
- Findings advocate for integrating socioeconomic data into engineering planning.

Methodological Contribution

This paper establishes a novel panel-data estimation framework, using two-way fixed effects models, specifically designed for evaluating engineered system adoption in low-resource settings.

This analysis provides evidence for targeted infrastructure investment and policy in Sub-Saharan Africa.



ABSTRACT-ONLY PUBLICATION

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