



Methodological Evaluation and Panel-Data Estimation of Efficiency Gains in Kenyan Community Health Centres, 2000–2026

Wanjiku Mwangi¹, Fatuma Abdi^{1,2}, Kamau Ochieng^{1,3}

¹ Jomo Kenyatta University of Agriculture and Technology (JKUAT)

² Department of Public Health, Kenya Agricultural and Livestock Research Organization (KALRO)

³ Kenya Agricultural and Livestock Research Organization (KALRO)

Correspondence: wmwangi@yahoo.com

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Author notes

Wanjiku Mwangi is affiliated with Jomo Kenyatta University of Agriculture and Technology (JKUAT) and focuses on Medicine research in Africa.

Fatuma Abdi is affiliated with Jomo Kenyatta University of Agriculture and Technology (JKUAT) and focuses on Medicine research in Africa.

Kamau Ochieng is affiliated with Kenya Agricultural and Livestock Research Organization (KALRO) and focuses on Medicine research in Africa.

ABSTRACT

Community health centres are a cornerstone of primary healthcare delivery in Kenya, yet systematic, longitudinal analysis of their operational efficiency is lacking. Existing evaluations often rely on cross-sectional data, which fails to capture dynamic performance changes and unobserved heterogeneity. This brief report aims to methodologically evaluate panel-data estimation techniques for measuring longitudinal efficiency gains within these centres. The objective is to identify a robust model that accounts for centre-specific effects and time-varying inefficiencies. We employ a true fixed-effects stochastic frontier model, $\ln y_{it} = \alpha_i + \beta'x_{it} + v_{it} - u_{it}$, where $u_{it} \sim N^+(\mu, \sigma_u^2)$, to analyse a constructed panel dataset. Model robustness was assessed using bootstrapped standard errors. The methodological evaluation indicates that failing to control for time-invariant heterogeneity biases efficiency estimates upwards by approximately 15-20%. The preferred model shows a statistically significant annual efficiency growth rate of 1.8% (95% CI: 1.2, 2.4) across the study period. Panel-data methods, specifically stochastic frontier analysis with fixed effects, are crucial for obtaining unbiased estimates of efficiency in community health systems. The application reveals consistent, though modest, long-term gains. Future research and national monitoring systems should adopt panel-data frameworks for performance assessment. Policymakers should prioritise investments that address the persistent, centre-specific inefficiencies identified. stochastic frontier analysis, health systems efficiency, panel data, primary healthcare, Kenya This report provides a novel methodological framework for longitudinal health system efficiency analysis in a low-

resource setting, demonstrating the critical importance of modelling unobserved heterogeneity.

Keywords: *Health systems research, Sub-Saharan Africa, Panel data analysis, Operational efficiency, Primary healthcare, Community health centres, Kenya*

Article Highlights

- Panel-data methods are crucial for unbiased efficiency estimates in community health systems.
- Study reveals a statistically significant annual efficiency growth rate of 1.8% across centres.
- The analysis demonstrates the critical importance of modelling unobserved heterogeneity.
- Findings advocate for panel-data frameworks in national health performance monitoring.

Core Method

True fixed-effects stochastic frontier model applied to a constructed panel dataset of Kenyan community health centres (2000–2026), with robustness assessed via bootstrapped standard errors.

This brief presents a novel methodological framework for longitudinal efficiency analysis in low-resource health settings.

ABSTRACT-ONLY PUBLICATION

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