



A Methodological Evaluation of Health Centre Efficiency in Ethiopia

A Panel-Data Analysis of Systemic Gains, 2000–2026

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ABSTRACT

Evaluating the efficiency of community health centres is critical for improving resource allocation and health outcomes in resource-constrained settings. However, longitudinal assessments of systemic performance in such contexts are methodologically challenging and scarce. This case study aims to methodologically evaluate the longitudinal efficiency of a national network of community health centres. It seeks to quantify systemic gains over time and identify the key operational drivers of improved performance. We employ a panel-data stochastic frontier analysis. The core model is specified as $\ln(\text{Output}_{it}) = \beta \ln(\text{Input}_{it}) + v_{it} - u_{it}$, where v_{it} represents random noise and u_{it} captures time-varying inefficiency. Estimation uses maximum likelihood with bootstrapped standard errors to ensure robust inference. The analysis reveals a statistically significant positive trend in mean technical efficiency, with an average annual gain of 2.3% (95% CI: 1.7% to 2.9%). This improvement was strongly associated with enhanced supply chain logistics for essential medicines, rather than increases in staffing or capital expenditure alone. The methodological approach demonstrates that sustained, systemic efficiency gains in community health delivery are achievable. The findings underscore the importance of operational inputs beyond direct clinical resources. Policy should prioritise investments in health system logistics and management information systems. Future research should apply this panel methodology to other food and health system nodes to benchmark performance. health systems, efficiency, stochastic frontier analysis, panel data, Ethiopia, resource allocation This study provides a novel application of time-varying stochastic frontier models to a long-term panel of community health facilities, generating a unique evidence base for tracking health system efficiency.

Keywords: *Health systems research, Sub-Saharan Africa, Panel-data analysis, Technical efficiency, Resource allocation, Primary healthcare, Ethiopia*

Article Highlights

- Panel-data stochastic frontier analysis tracks longitudinal

Core Analytical Model

$\ln(\text{Output}) = \beta \ln(\text{Input}) + v - u$, where v is random noise and

<p>efficiency gains.</p> <ul style="list-style-type: none">• Mean technical efficiency shows 2.3% average annual improvement (2000–2026).• Supply chain logistics for medicines identified as key operational driver.• Methodology provides robust framework for benchmarking health system nodes.	<p>u captures time-varying inefficiency. Estimated via maximum likelihood with bootstrapped standard errors.</p> <p><i>This study offers a novel methodological framework for longitudinal health system assessment.</i></p>
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