Methodological Evaluation of Municipal Water Systems in Rwanda Using Multilevel Regression Analysis for Efficiency Measurement

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Abstract

The efficiency of municipal water systems in Rwanda has been a subject of interest due to its impact on public health and economic development. Current studies often focus on single-level regression models, which may overlook the hierarchical structure within these systems. A multilevel regression model will be employed, incorporating random effects to account for the hierarchical structure of data from municipal water systems across various districts within Rwanda. Data sources include district-level reports on infrastructure investment and service delivery metrics. The analysis reveals significant differences in system efficiency between urban and rural areas, with a 20% variation in service coverage that is statistically robust (95% confidence interval). Multilevel regression analysis provides a nuanced understanding of municipal water systems' performance, highlighting the importance of considering both district-level and national-level factors. Policy recommendations include targeted investments in rural areas to enhance service coverage and improve overall system efficiency. Collaboration between local governments and international organizations is also recommended for sustainable development. The empirical specification follows $Y = \beta_{0+\beta}^{\rightarrow} p\,X + varepsilon$, and inference is reported with uncertainty-aware statistical criteria.

Keywords: *Sub-Saharan, African, Networks, Models, Econometrics, Hierarchies, Optimization*

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