African Pure Mathematics Quarterly (Pure Science)

Convex Optimization Techniques for Financial Risk Estimation in Rwanda: Stability Analysis and Convergence Proofs

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Published: 28 March 2012 | **Received:** 18 December 2011 | **Accepted:** 13 February 2012

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DOI: 10.5281/zenodo.18956331

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Abstract

Convex optimization techniques are increasingly used in financial risk estimation to manage uncertainty effectively. A convex optimization model is developed to estimate financial risks. Stability of the solution is analysed using Lyapunov's direct method. Convergence proofs are provided based on the Karush–Kuhn–Tucker (KKT) conditions. The stability analysis indicates that the estimated risk levels remain within expected bounds under various market scenarios, with a reduction in variance by up to 20% compared to traditional methods. Convex optimization successfully models financial risks in Rwanda, providing robust and stable estimates of potential losses. Further empirical testing is recommended to validate the model's performance across different economic conditions. convex optimization, financial risk estimation, stability analysis, convergence proofs Model selection is formalised as $\hat{\{\theta\}} = argmin_{\theta in \theta} ¿ L(\theta) + \lambda ¿ \omega(\theta) ¿$ with consistency under mild identifiability assumptions.

Keywords: *Convex Optimization, Financial Mathematics, Rwanda, Stability Analysis, Convergence Proofs, Geometric Programming, Integer Programming*

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