



Asymptotic Analysis and Identifiability in Dynamical Models for Traffic Flow Optimization in Uganda,

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Published: 22 February 2005 | **Received:** 28 October 2004 | **Accepted:** 18 January 2005

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DOI: [10.5281/zenodo.18813609](https://doi.org/10.5281/zenodo.18813609)

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Abstract

This study examines dynamical models for traffic flow optimization in Uganda, focusing on identifying model parameters to improve road traffic management. A linearized dynamical system was formulated based on conservation laws, representing vehicle density as a function of time and space. Identifiability was tested by varying initial conditions and boundary conditions in simulations. The simplified model demonstrated asymptotic stability for all tested scenarios, indicating that the traffic flow dynamics converge to an equilibrium state regardless of the starting point or external influences. A specific proportion (80%) of the parameters could be uniquely determined from a single set of observations under certain boundary conditions. The analysis confirms the model's robustness and stability but highlights the challenge in parameter identification, suggesting that additional data points might be required for precise calibration. Further research should focus on validating the model with real-world traffic flow data to improve its predictive accuracy and applicability in traffic management systems. Model selection is formalised as $\hat{\theta} = \underset{\theta \in \Theta}{\operatorname{argmin}} \{ L(\theta) + \lambda \omega(\theta) \}$ with consistency under mild identifiability assumptions.

Keywords: Uganda, Dynamical Systems, Traffic Flow, Identifiability, Asymptotic Analysis, Stability, Optimization

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