UNIVERSITY OF TORONTO
FACULTY OF ARTS & SCIENCE | Department of Mathematics

Departmental PhD Thesis Exam

Thursday, April 2, 2026, at 10:00 a.m. (sharp)
at SGS109/Zoom, with Zoom overflow in BA6290B

PhD Candidate : Cameron Davies

Supervisor : Robert McCann

Thesis title : Optimizing Emissions Control Policies with Linear Programming

Abstract

The climate crisis has created a moral and strategic imperative for countries to rapidly reduce industrial greenhouse gas emissions. To maintain public and industrial support, these policies must account for the heterogeneity of individual industries.

This work uses linear programming techniques to inform the design of climate policies. Specifically, within a given industry, we extend an economic model of Newell and Stavins to model the cost and effectiveness of policies designed to limit emissions while encouraging production. Our extension results in a linear program which is reminiscent of the Kantorovich problem in optimal transport, and which likewise admits both primal and dual linear programming problems. Interpreting the primal problem as command-and-control policies, and the dual as market-based policies (based on emissions taxes and production subsidies), we show that strong linear programming duality fails for certain emissions targets. This means that market-based policies may fail to meet emissions targets, even in contexts where these are attainable through a command-and-control approach.

However, we show that this model can be saved, and strong duality can be restored, by implementing a progressive, rather than a flat-rate, emissions tax, bolstering the case for progressive emissions taxation. We also show that strong duality can be restored by restricting the range of post-regulation outcomes to a compact set; this can be interpreted as a hybrid policy approach, which combines elements of both command-and-control and market-based policy.