

---

# Table of Contents

Preface	1
Summary	3
Chapter 1: Transportation Model Enhancements	7
Introduction	7
Overview of the Portland Modeling System	7
Model Enhancement Strategy	9
Conclusions	25
Chapter 2: Land Use Model	29
EMPAL Calibration	29
The Mathematical Formulation of EMPAL	30
Evaluating the Calibration Procedure	31
The EMPAL Data Sets for Detroit, Kansas City and Portland	33
Calibration Results for the Standard EMPAL Model	34
Inconsistencies between the Base Year and Lag Year Employment Data	37
Using Lagged Total Employment as a Variable in the EMPAL Attractiveness Term	41
Spatial Aggregation Tests for Portland	45
Controlling for the Urban Growth Boundary	49
Conclusions	50
DRAM Calibration	52
The Mathematical Formulation of DRAM	53
The Calibration Procedure	54
The DRAM Data Sets for Detroit, Kansas City and Portland	55
Calibration Results for the Standard DRAM Model	57
Spatial Variation: Using Census Tract Data	62
Extensions to the Standard DRAM Formulation	64
Including an Additive Lag Term in the DRAM Model	65
Calibration Results for a DRAM Model with an Additive Lag Term	66
Inconsistencies between the Base Year and Lag Year Household Data	66
Including a Multiplicative Lag Term in the DRAM Model	73
Spatial Aggregation Tests for Portland	75
Including Land Value as a Variable in the DRAM Model	79
Conclusions	81
Appendix	83
Calibration Results for the EMPAL Model	83
Calibration Results for the DRAM Model	84