

Tour-Based Microsimulation Model: Case Study in Calgary, Alberta

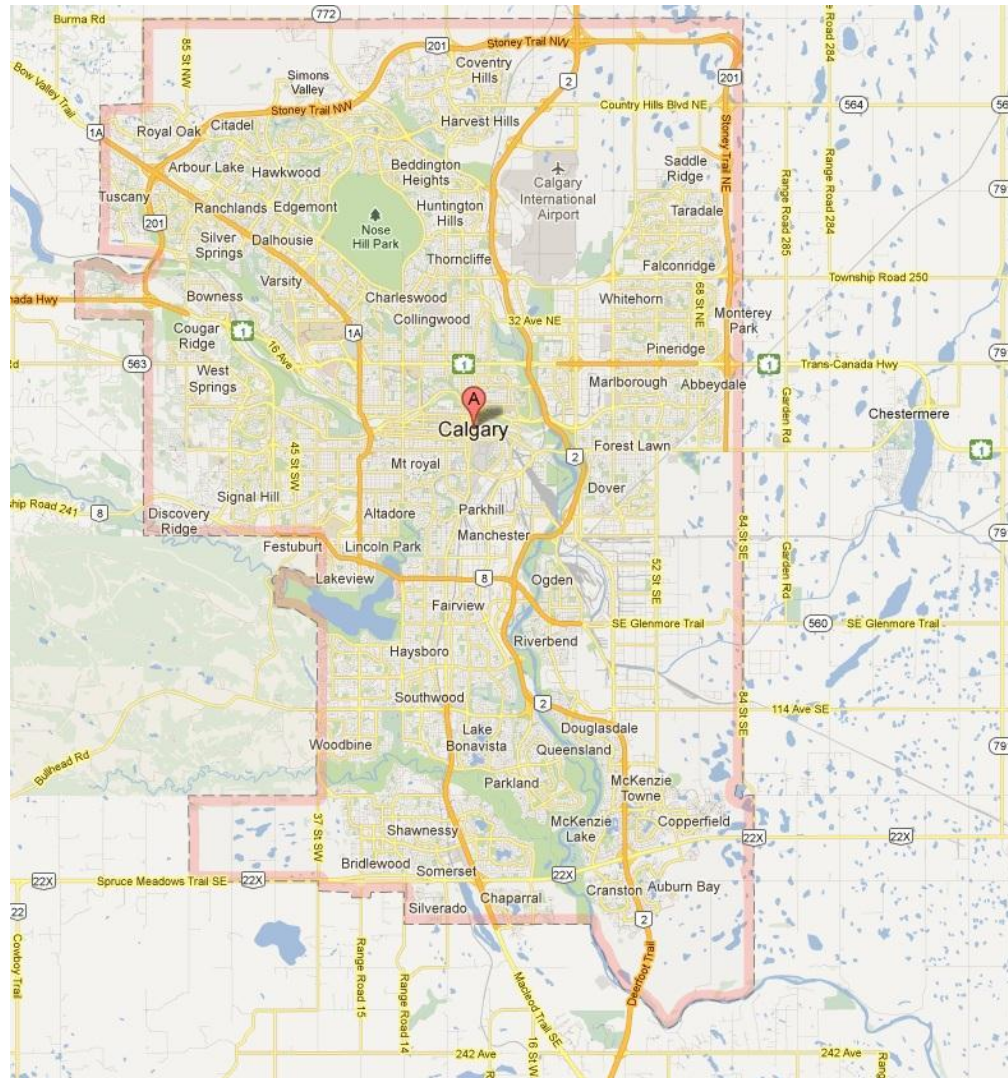
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CEE 298

Introduction

- Population: 1 million people
- Key hub for transporting to western Canada
- Consists many strategic highway and railroad routes for commercial traffic
 - CANAMEX Corridor, Trans-Canada Highway
 - Canadian Pacific Railway, Canadian National Railway

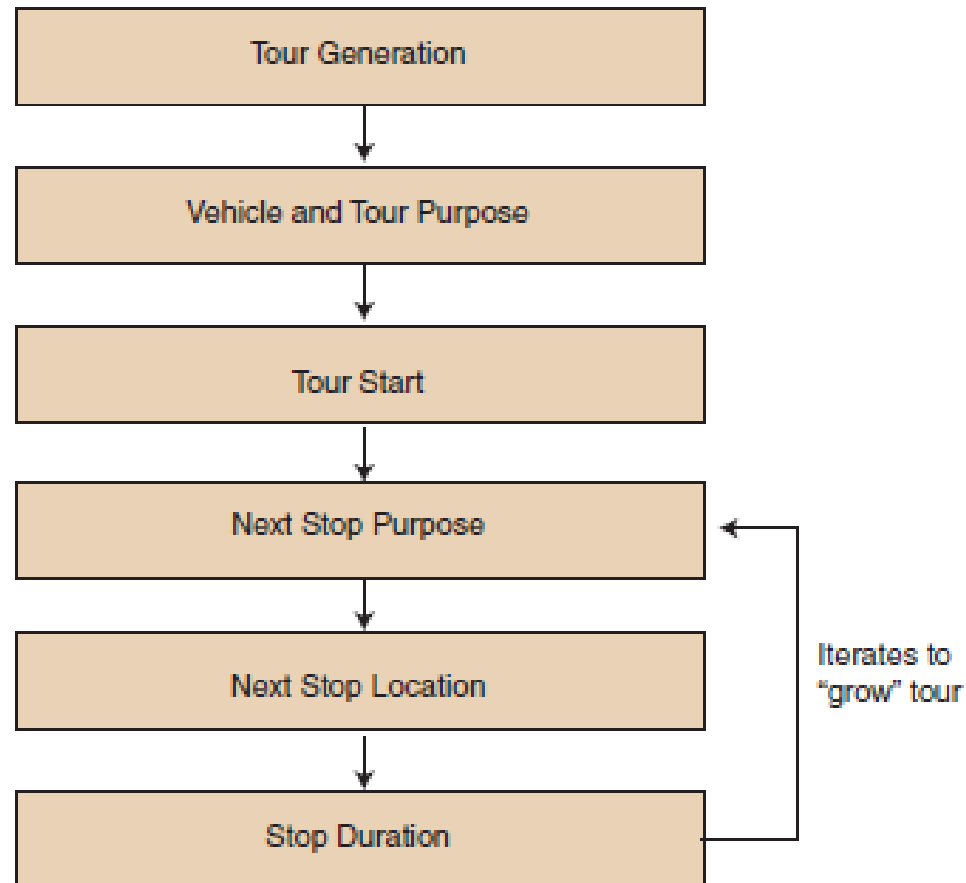
Introduction



Model Development

- Urban Commercial Movements – trips where “the trip-maker is being reimbursed for making the trip above and beyond the reimbursement of travel costs”
- Extensive survey done in 2001
 - 3,000 businesses/establishments participated
 - 24 hour trip diaries for typical weekday
 - Origins, destinations, trip purpose, commodities, etc.

Model Development



Model Development

- Five Establishment Categories (NAICS):
 - Industrial
 - Agriculture, manufacturing, construction, etc.
 - Wholesale
 - Retail
 - Service
 - Professional/technical services, health care/social assistance, etc.
 - Transportation

Tour Generation

- Tour trip rates per employee for each establishment category are generated via an exponential regression model.
- Tours are then allocated to five different time periods based on a logit model.
- Discrete tours result.

Tour Generation Results

- Accessibility decreases the tour rate.
- Most commercial movements begin in the AM Peak or Midday Offpeak.

Vehicle and Tour Purpose

- Vehicles: Light, Medium, Heavy
- Purposes: Goods, Services, Other
- Monte Carlo process used
- Probabilistic discrete choice logit model

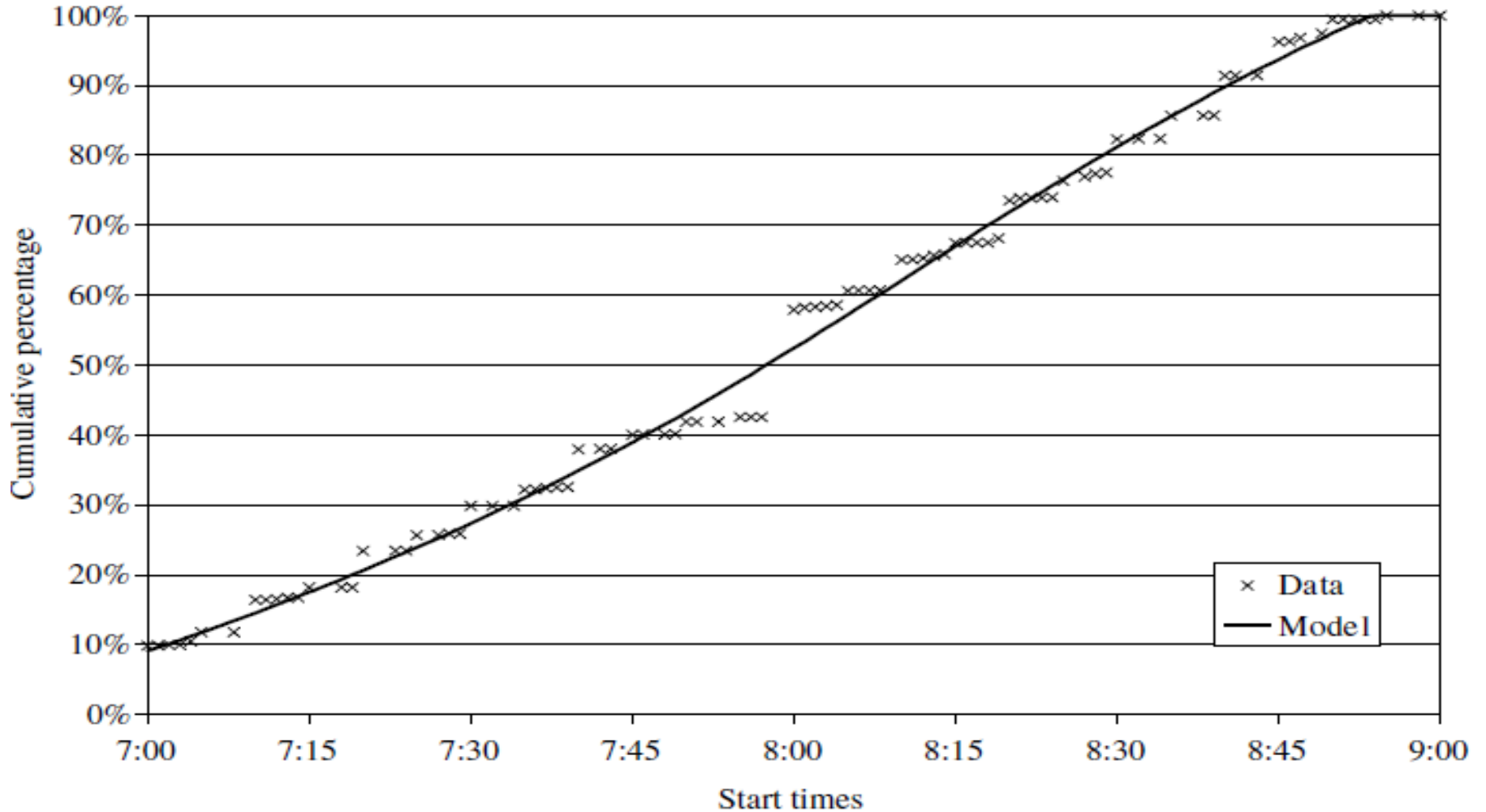
Vehicle and Tour Purpose Trends

- Service tours made more frequently than goods tours.
- Light vehicles used more than medium and heavy vehicles.
- Goods tours most common in Industrial and Wholesale areas.

Tour Start Time

- Based on what time period the tour was allocated to in the tour generation step, a specific start time is assigned via a Monte Carlo process.
- Distributions based on weighted sample of observed start times.

Tour Start Time



Next Stop Purpose

- Purpose: Goods, Services, Other, Return
- Goods and Services cannot change from its primary purpose.
 - S-S-L: service tours by Services establishments using light vehicles;
 - S-S-MH: service tours by Services establishments using medium or heavy vehicles;
 - G-S-LMH: goods tours by Services establishments using any vehicle type;
 - S-R-LMH: service tours by Retail establishments using any vehicle type;
 - G-R-LMH: goods tours by Retail establishments using any vehicle type;
 - S-I-L: service tours by Industrial establishments using light vehicles;
 - S-I-MH: service tours by Industrial establishments using medium or heavy vehicles;
 - G-I-LMH: goods tours by Industrial establishments using any vehicle type;
 - S-W-LMH: service tours by Wholesale establishments using any vehicle type;
 - G-W-L: goods tours by Wholesale establishments using light vehicles;
 - G-W-MH: goods tours by Wholesale establishments using medium or heavy vehicles;
 - B-T-LMH: business tours by Transport establishments using any vehicle type; and
 - O-X-LMH: other tours by any establishments using any vehicle type.

$$U_{\text{business}} = [\phi_{\text{business previous}} \times \ln(\text{number of previous business stops})]$$

$$+ ASC_{\text{business}}$$

$$U_{\text{other}} = [\phi_{\text{other previous}} \times \ln(\text{number of previous other stops})]$$

Company Types/ Tour Purpose/ Vehicle Type(s)	ASC Business	ASC Other	ASC Return	Business Previous	Other Previous	Total Previous	Elapsed Time	Travel Time ($\times 10^{-3}$)	Other Elapsed Time	Return Gen. Cost ($\times 10^{-2}$)
All/other/all	na	0	4.083	na	0	-3.380	0.7893	0	0	26.96
Private service/service/light	2.936	0	2.639	0.3514*	0.2715**	-1.045	0.2539	5.969	0.1046*	3.981
Private service/service/ medium and heavy	2.352	0	2.162	0.4774	1.053	-0.7774	0.3402	2.587	0.1048	6.057
Private service/goods/all	2.284	0	1.648	1.133	1.336	-0.5174	0.3909	6.431	0.2716	1.106**
Retail/service/all	2.707	0	2.619	0.6021	0.9202	-0.1112**	0.1837	-0.8995**	0.1532	5.538
Retail/goods/all	3.725	0	3.411	0.1141**	1.557	-1.519	0.2083	8.930	-0.1128**	-3.348
Industrial/service/light	2.525	0	2.978	1.075	1.121	-0.9242	0.3525	3.123	0.2234	3.253*
Industrial/service/ medium and heavy	2.599	0	2.364	6.148×10^{-2} **	1.202	-1.133	0.3025	9.960	0.1187	10.75
Industrial/goods/all	2.890	0	3.041	0.3996	0.9585	-1.127	0.2748	4.555	0.1103	3.335
Wholesale/service/all	2.302	0	2.028	0.9692	1.159	-0.3461*	0.3419	2.754**	0.1509	9.744
Wholesale/goods/light	3.448	0	1.823	0.4821*	1.412	-0.4929*	0.2715	4.501*	-0.1719	1.402**
Wholesale/goods/medium and heavy	2.984	0	1.687	0.3894	1.316	-0.4665	0.1746	10.28	6.591×10^{-3} **	2.118**
Transportation/na/all	2.901	0	2.541	1.395	2.174	6.366×10^{-2} **	0.2944	1.819	0.2447	7.048

NOTE:

na = not applicable.

Unless otherwise noted, all significant at the 99.9% level (t -ratio > 3.29).

*Indicates significance at the 95% level (t -ratio > 1.96) but not at the 99.9% level (t -ratio < 3.29).

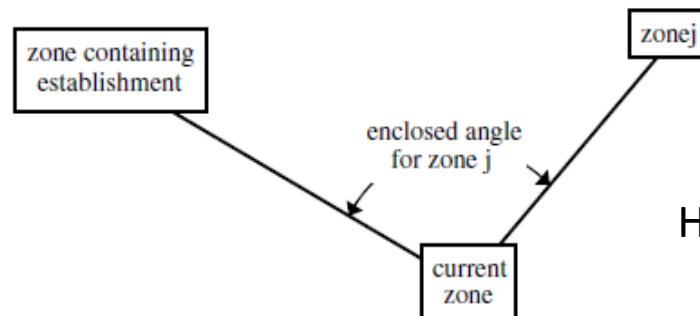
**Indicates significance at less than the 95% level (t -ratio < 1.96).

Hunt et al 2005

Next Stop Location

- 1,447 possible zones

$$U_{\text{zone } j} = \theta_{\text{land use}} + \theta_{\text{average income}} \times \text{average household income in zone } j \\ + \theta_{\text{trip gen utility}} \times \text{travel utility for trip from current zone to zone } j \\ + \theta_{\text{next return gen utility}} \times \text{travel utility for trip from zone } j \text{ to zone containing establishment} \\ + \theta_{\text{pop acc}} \times \text{accessibility to population for zone } j \\ + \theta_{\text{emp acc}} \times \text{accessibility to employment for zone } j \\ + \theta_{\text{enclosed angle}} \times \text{enclosed angle for zone } j \\ + \theta_{\text{size term}} \times \ln(\text{population in zone } j + \theta_{\text{emp/pop size term}} \times \text{employment in zone } j) \\ + \theta_{\text{attractor}} \times \ln(\text{attractor score for zone } j)$$



Hunt & Stefan 2007

Next Stop Location

Company Types/ Tour Purpose/ Vehicle Type(s)	Low Density Land Use	Comm.– Retail Land Use	Industrial Land Use	Employ. Node Land Use	Average Income ($\times 10^{-6}$)	Gen. Cost of Travel	Return. Gen. Cost	Population Accessib. ($\times 10^{-6}$)	Employ. Accessib. ($\times 10^{-6}$)	Enclosed Angle ($\times 10^{-3}$)	Size Term	Relative Employ. Size Term
All/other/all	-0.7902	0.02702**	-0.1595*	-0.6126	-11.49	0.3039	0.1310	-7.651	-9.696	-2.346	0.2800	6.779
Private service/service/light	-0.08976*	-0.2755	0.2152	-0.4623	1.676*	0.3283	0	-10.83	-2.653	-1.884	0.3094	0.08658**
Private service/service/ medium and heavy	0.7250	-0.1057**	0.4655	-0.7546	9.476	0.08481	0.1229	-44.65	9.296	3.684	0.2219	0
Private service/goods/all	-0.3327*	0.5674	0.4926	0.2062	0	0.5688	0	5.717*	-16.54	-6.348	0.1588	0
Retail/service/all	-0.9676	-0.2310	0.1547*	-0.5132	0	0.3601	0.03662	-17.35	0	-1.241*	0.2841	0.6334
Retail/goods/all	-0.1707	-0.0256**	0.8014	-0.1840	0	0.3734	0.09158	-13.32	-1.682*	1.914	0.2067	1.633
Industrial/service/light	-1.144	-0.2361	0.05026**	-0.4182	0	0.2869	0	-24.98	5.477	-3.067	0.2371	1.231
Industrial/service/ medium and heavy	0	-0.3231*	0.2789*	-0.8438	0	0.1627	0.1279	-13.25	-16.96	2.934	0.1205	1.012**
Industrial/goods/all	0	-0.1497	0.5575	-0.2042	0	0.2581	0.09615	-10.68	-5.139	-2.146	0.2722	0
Wholesale/service/all	-0.9340	-0.2130*	0.1440**	-0.4410	2.367**	0.3849	0.04300*	-11.81	-27.71*	1.761	0.2426	2.138
Wholesale/goods/light	-0.6668	0	0.9271	-0.2688	0	0.4495	0.1075	-32.84**	-67.74	0.8923	0.2248	0
Wholesale/goods/ medium and heavy	-0.1226**	0	0.1445*	-0.1183*	0	0.3123	0.03430	-31.84	5.950	-1.431*	0.3021	2.313
Transportation/na/all	-0.5279	0.1004	0.6275	0.02668**	-4.691	0.3792	0	-11.72	-5.984	3.109	8.651×10^{-2}	na

NOTE: na = not applicable.

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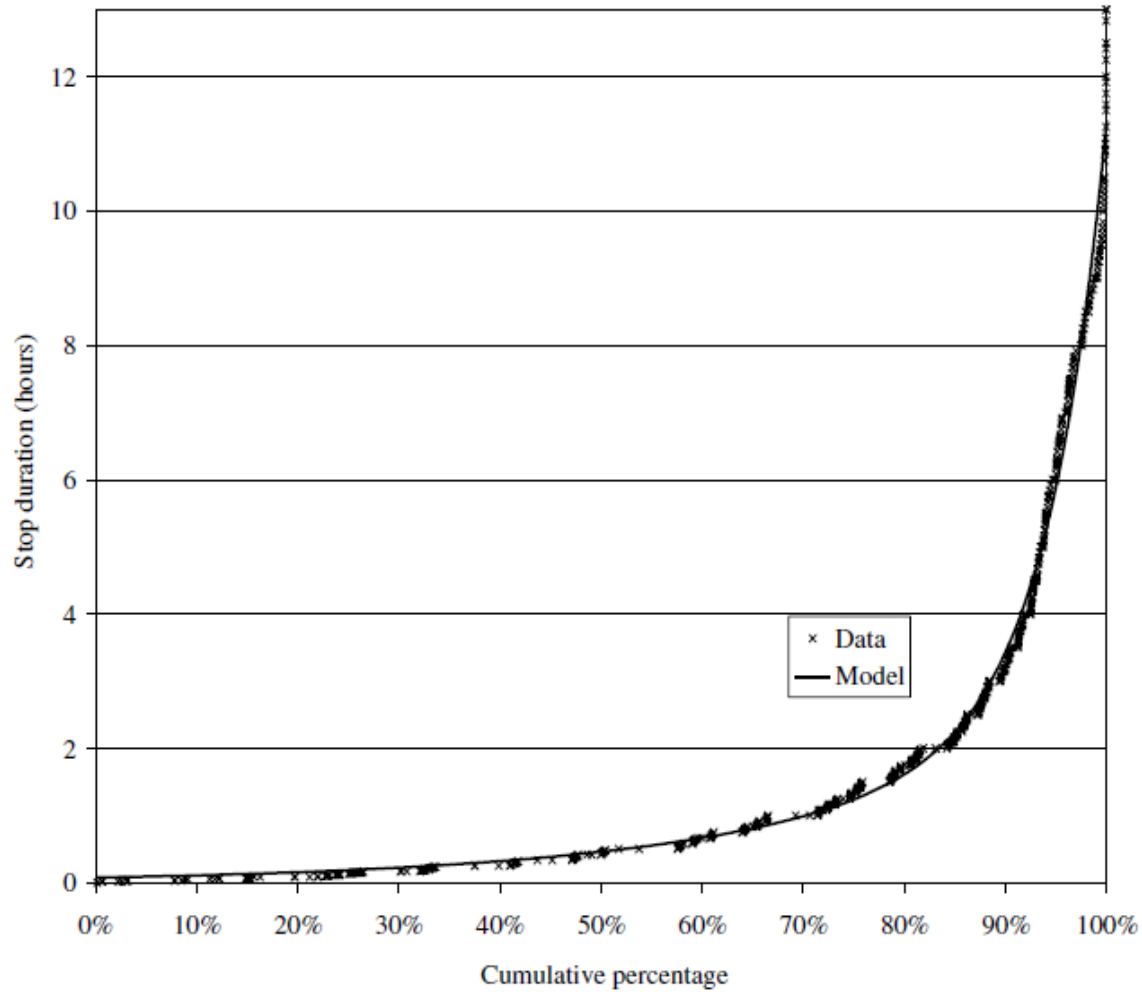
**indicates significance at less than the 95% level (t -ratio < 1.96).

All other values significant at the 99.9% level (t -ratio > 3.29).

Hunt et al 2005

Stop Duration

- Si



Pros and Cons

- Pros
 - Able to respond to policy measures
 - Captures LCV and service movements
 - Accurate
- Cons
 - Time-intensive
 - Data-intensive
 - Does not capture intermodal transport

Thank You!
Questions?