Reroute or Wait It Out:

Estimating Optimal Route Decisions in the Presence of Unexpected Delays

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Outline

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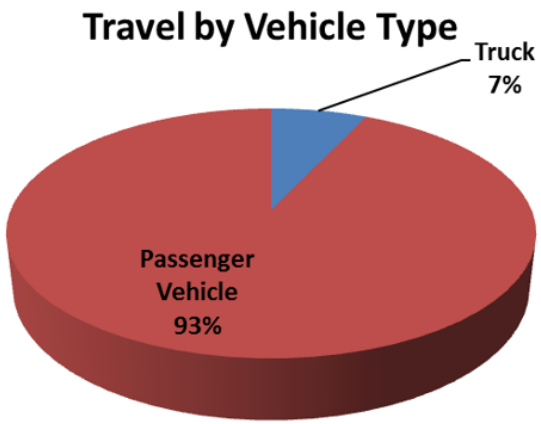
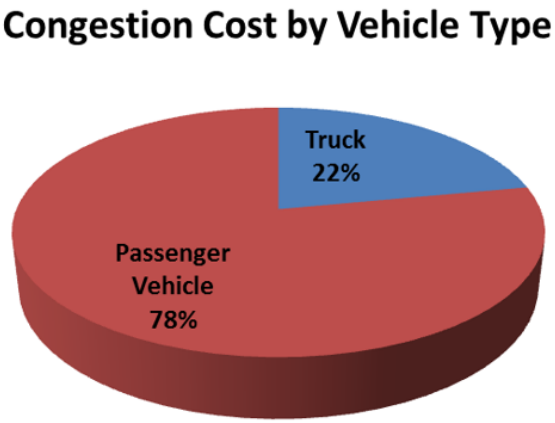
Problem

- Trucks make up a small percentage of road users, but bear a large percent of the costs from delays.
  - increased labor costs, wasted fuel, etc...





Contribution

- The purpose of this paper is to determine whether drivers are making optimal routing decisions.

Research Question:

"Are drivers making optimal reroute and waiting decisions in the presence of an unexpected delay?"

Lit Review

- Demand at time t is different than demand at time $t+1$.
  [Hsiao - 2009]
- Customers "trade off price for waiting time."
  [Allon, Federgruen, & Pierson - 2011]
- "Drivers are not committed to a single route."
  [Huchingson, McNees, & Dudek - 1977]
- Shorter travel time "appears among the few most important independent variables."
  [Wachs - 1967]
- Mean-variance model
  [Abdel-Aty, Kitamura, & Jovanis - 1997], [Jackson & Jucker - 1981]
- ...

Data

- Origin-destination survey by Washington State University and the Washington DOT.
- 4600 truckers surveyed on I-90, the major thoroughfare between Eastern and Western Washington.
- origin, destination, commodity, weight, truck configuration, route frequency, origin/destination facility, etc...

Data

- Survey questions of interest:

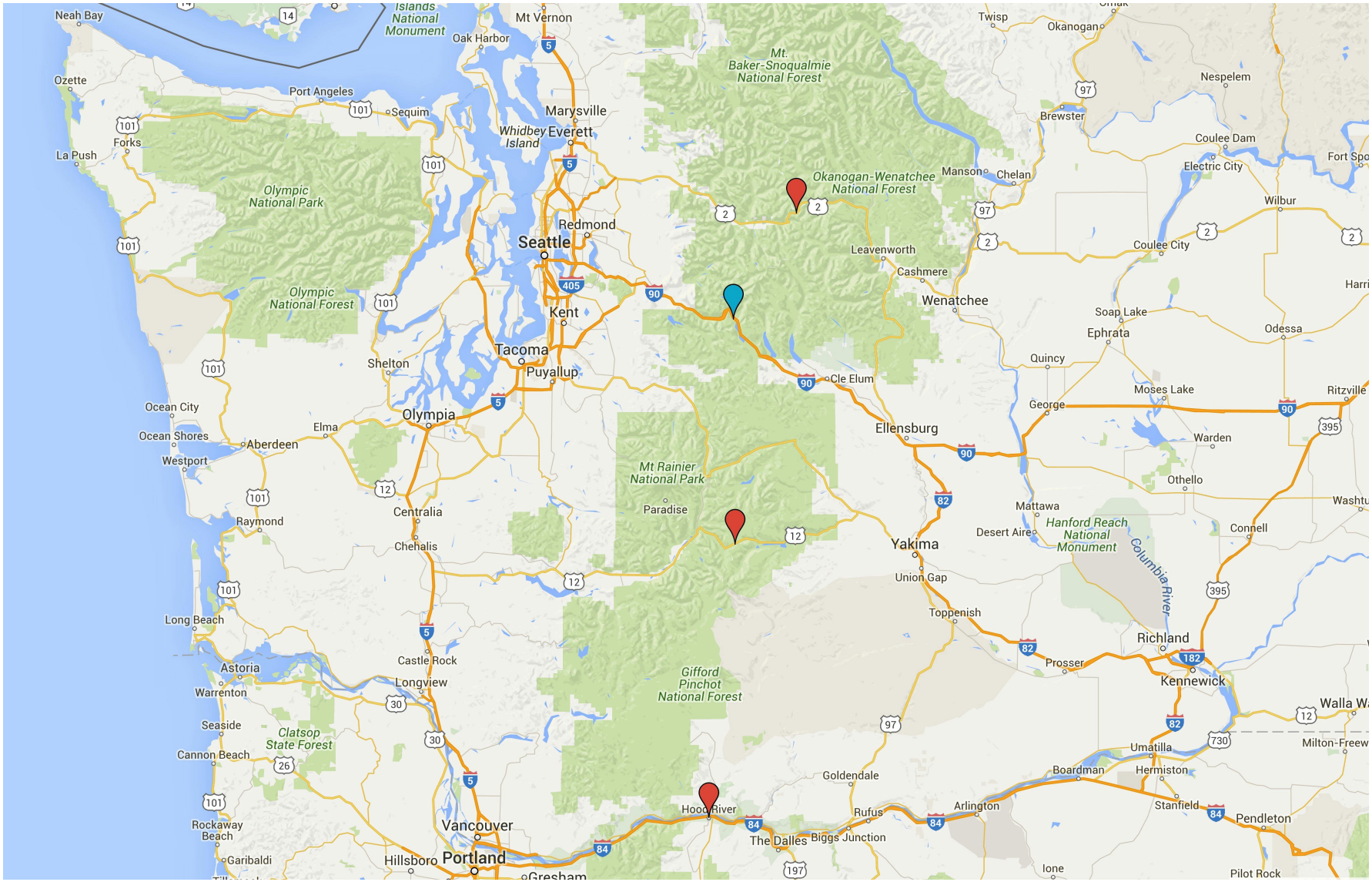
  "In the event of a weather related closure on Snoqualmie Pass, how long are you willing to wait before taking an alternative route?"

  - categorical: 0 hours, 1 hour, 3 hours, 5 hours, 5+ hours, Don't know

  "When you decide to reroute, what alternative route would you most likely use?"

  - free response

Reroute


Neah Bay
Islands National Monument
Mt Vernon
Oak Harbor
Twisp
Okanogan
Mt. Baker-Snoqualmie National Forest
Ozette
Port Angeles
Sequim
Marysville
Whidbey Island
Everett
Nespelem
Brewster
Forks
La Push
Coulee Dam
Electric City
Fort Spo
Olympic National Park
Okanogan-Wenatchee National Forest
Manson
Chelan
Wilbur
Redmond
Seattle
Leavenworth
Coulee City
Cashmere
Olympic National Forest
Kent
Wenatchee
Soap Lake
Ephrata
Odessa
Tacoma
Puyallup
Shelton
Quincy
Cle Elum
Ocean City
Olympia
Moses Lake
George
Ritzville
Ocean Shores
Elma
Aberdeen
Ellensburg
Westport
Warden
Mt Rainier National Park
Othello
Centralia
Paradise
Mattawa
Raymond
Hanford Reach National Monument
Desert Aire
Connell
Chehalis
Yakima
Union Gap
Columbia River
Long Beach
Toppenish
Richland
Castle Rock
Prosser
Astoria
Longview
Gifford Pinchot National Forest
Kennewick
Warrenton
Seaside
Clatsop State Forest
Umatilla
Milton-Freew
Cannon Beach
Goldendale
Boardman
Hermiston
Hood River
Rufus
Arlington
Stanfield
Pendleton
Rockaway Beach
Vancouver
The Dalles
Biggs Junction
Garibaldi
Hillsboro
Portland
Gresham
Ione
Pilot Rock

Model

- 3 reroute models to be estimated
  - Base model:

    $optimal\ reroute = f\,(route\ duration)$
  - Intermediate model:

    $optimal\ reroute = f\,(route\ duration, congestion)$
  - Full model:

    $optimal\ reroute = f\,(route\ duration, congestion, alternate\ pass\ closure)$

Base Model

- $optimal\ reroute = f\,(route\ duration)$
  - calculate the average route duration time via Google Maps Distance Matrix API (without traffic)

Intermediate Model

- $optimal\ reroute = f\,(route\ duration, congestion)$
  - calculate the average route duration time via the API (includes congestion)
  - calculate each unique destination over all 3 routes each hour of the day
  - 50,000+ routes

Full Model

- $optimal\ reroute = f\,(route\ duration, congestion, alternate\ pass\ closure)$
  - Given that I-90 is closed, what is the probability that the alternate route pass will be closed?
  - past 5 years of closure data
  - calculate average closure times
  - $penalty = P\,(closure|SP) * average\ closure + [1 - P\,(closure|SP)] * 0$

Results - Reroute

Optimal Route vs Stated Preference

Stated Preference	Google2	Google12	Google84
		Base Model	
US2	**41.2%**	19.0%	30.0%
US12	35.9%	**47.6%**	40.0%
I-84	22.8%	33.3%	**40.0%**
		Intermediate Model	
US2	**43.0%**	17.9%	31.3%
US12	34.7%	**54.7%**	25.0%
I-84	22.3%	27.4%	**43.8%**
		Full Model	
US2	**53.2%**	26.4%	19.0%
US12	27.7%	**49.1%**	19.0%
I-84	19.1%	24.4%	**61.9%**

Results - Distribution

Distribution of Optimal Routes and Stated Preferences

Route	Stated Preference	Base Model	Intermediate Model	Full Model
US2	40.3%	97.2%	88.3%	53.0%
US12	36.6%	1.9%	10.1%	43.0%
I-84	23.1%	0.9%	1.5%	4.0%

Results - Delay

Delay Time vs Stated Preferences

Delay Time (description)	Delay Time (minutes)	% Break-Even > Delay Time	% Stated Pref. > Delay Time
		Eastbound	
Ave. Closure	64	100.0%	75.7%
Ave. + 1 Std. Dev.	135	90.7%	75.7%
Ave. + 2 Std. Dev.	205	2.3%	62.7%
Ave. + 3 Std. Dev.	275	0.1%	62.7%
		Westbound	
Ave. Closure	61	100.0%	76.8%
Ave. + 1 Std. Dev.	150	83.7%	76.8%
Ave. + 2 Std. Dev.	239	2.2%	61.9%
Ave. + 3 Std. Dev.	328	0.1%	56.2%

Extensions

- Determine which drivers choose the optimal route and/or optimal waiting time
- Calculate cost in lost efficiency
- Sensitivity analysis