TRAVEL PATTERNS IN INDIAN DISTRICTS:
DOES POPULATION SIZE MATTER?

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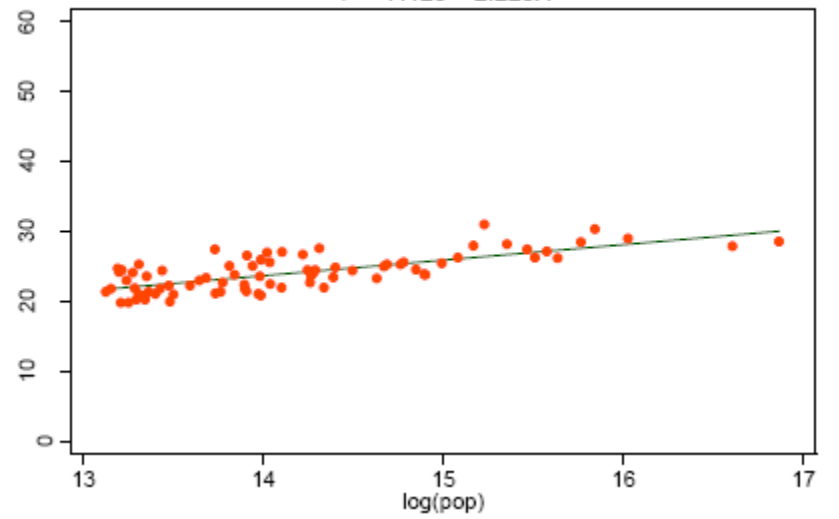Delhi

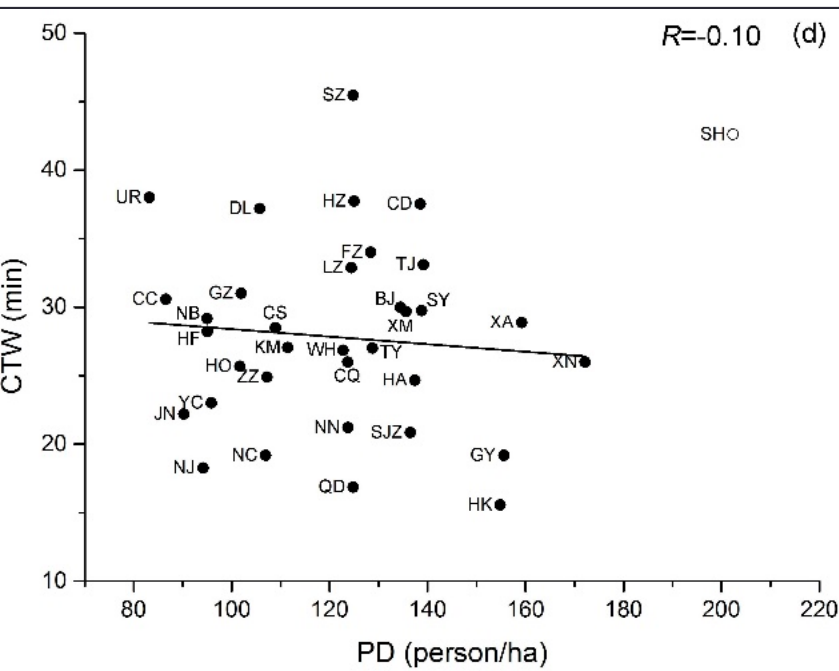Dr. Geetam Tiwari

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Urban form and Travel behaviour

Metro wide mean commute time
Y = -7.428 + 2.220X

Source: Lee and Gordon (2011), drive alone mode
Study of 79 largest U.S. metro areas

Source: Song et al. (2017), Commuting travel time
and population density, 35 cities of China

- High Density is correlated with share of short distance trips (+)

- High density is correlated with NMT share (+)

- High mix land use intensity is correlated with less car use (-)

- High mix land use intensity is correlated with short distance trips (-)

Source: LSE cities 2014
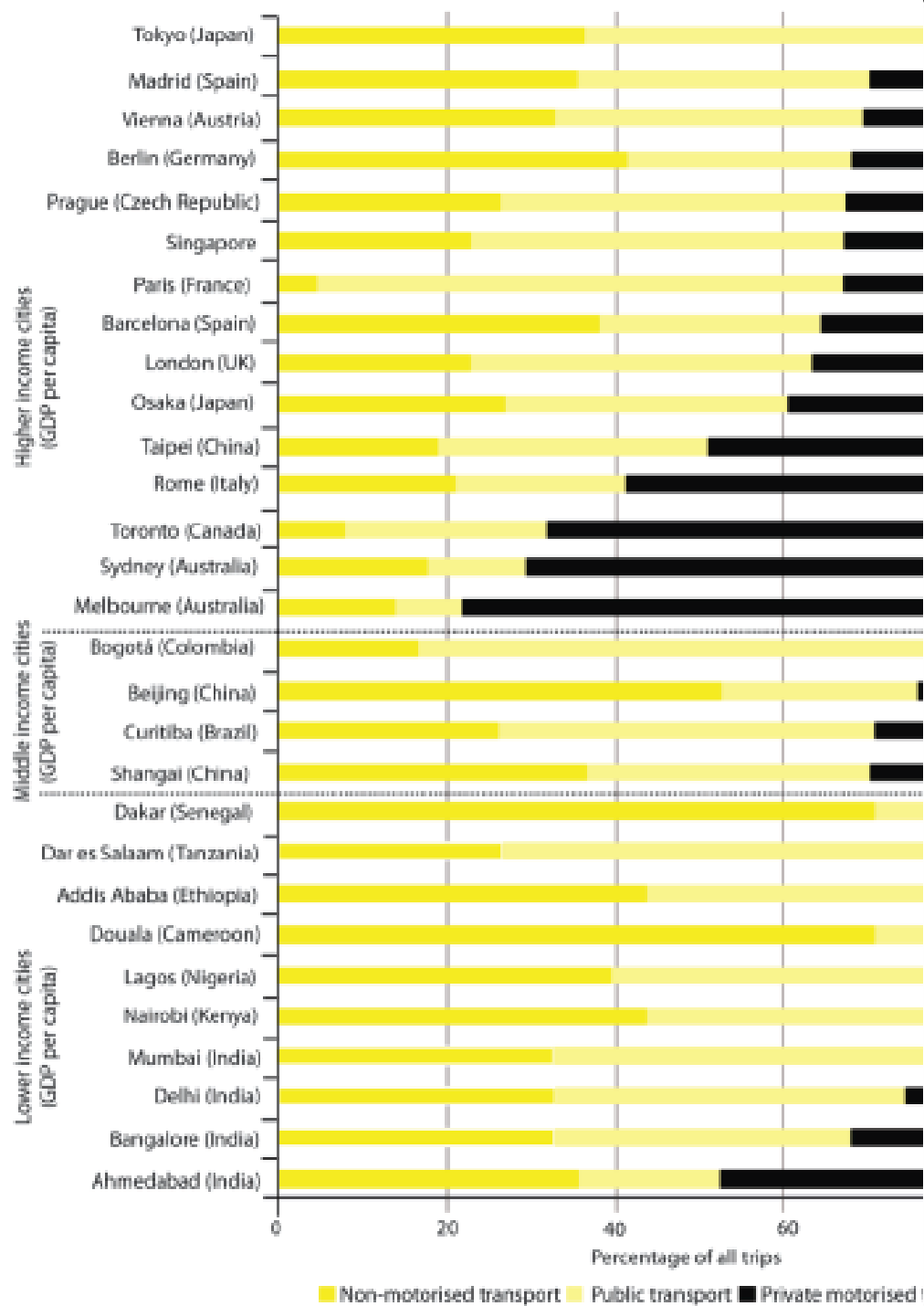
In India

- Only few examples of studies exists
  - MOUD – Wilbur Smiths Report on 30 Indian cities
  - Exclusive studies for
    - Ahmedabad
    - Rajkot
    - Vishakhapatnam
    - Delhi
    - Mumbai
    - Agartala
  - No comprehensive comparison of travel behavior respect to socio-economic structure of cities
- Relevant travel behavior data collected by Cer of India (2011) is available at district level
  - Other workers
  - Only for work trips

Need for the research
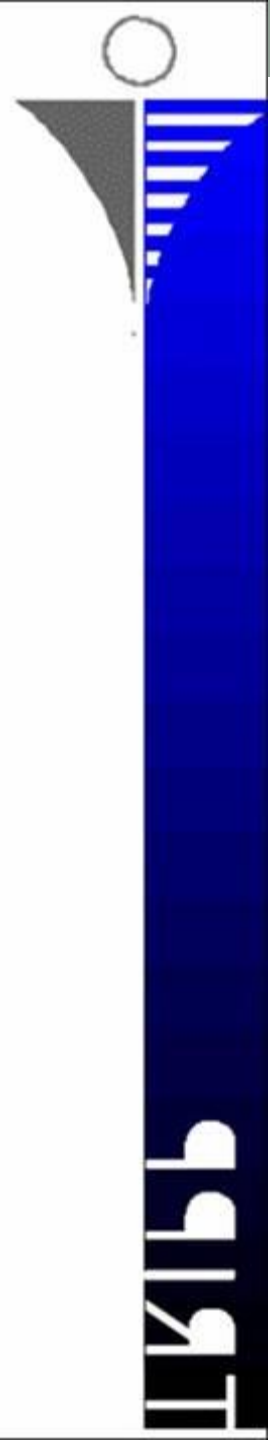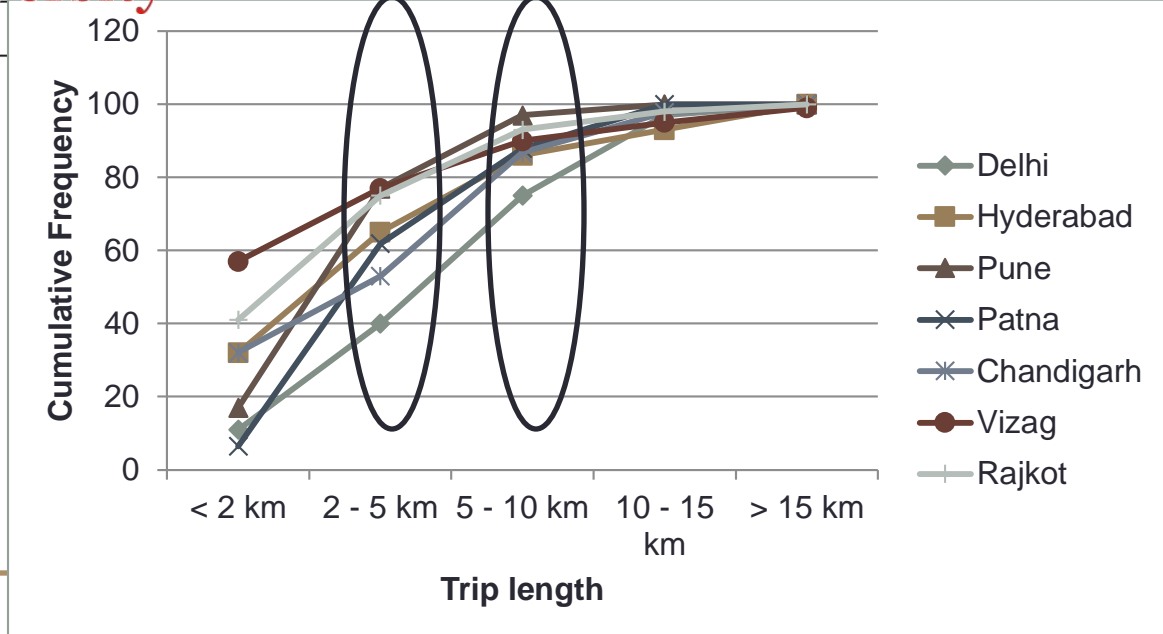
City form group				Cities
1				Berlin
				Milan
				Madrid
				Kiev
				Bueno
				Cordo
				Porto
				Rio De
				Sao Pa
				Santia
				San Sa
				Teguci
				Guada
				Mexic
				Monte
				Manag
				Monte
2	Asia	Calcutta	Asia	Kanpu
	Asia	Chennai-madras	Asia	Bomba
3	Asia	Chongqing	Asia	Nagpu
	Asia	Shanghai	Asia	New D
	Asia	Tianjin	Europe	St. Pet
	Asia	Ahmedabad	Latin America	Sante
				Bogota
	Asia	Bangalore	Latin America	Caraca
	Asia	Hyderabad		
4	Asia	Osaka	Latin America	Quito

Cities classification based on area weighted mean shape index; area weighted mean
fractal dimension; compactness index; compactness index of the largest
Patch and ratio of open space; Source: Huang et al. 2007

Research question and objectives

- Aim
  - To understand the variation in travel behavior across districts in India
- Objectives
  - Null Hypothesis 1: The trip length does not significantly varies by population in India
  - If in case 1, null hypothesis is rejected then;
  - Null Hypothesis 2: Trip length does not significantly varies with respect to the socio-economic structure of the cities

Methodology

Identification of data set and variables

Collating data

Source of data –
- Census of India 2011
- District stats of India
- District census handbook

Correlation analysis

Classification of entities

Economic variables

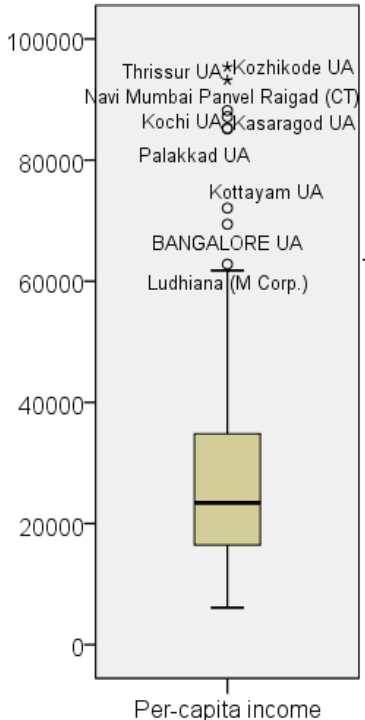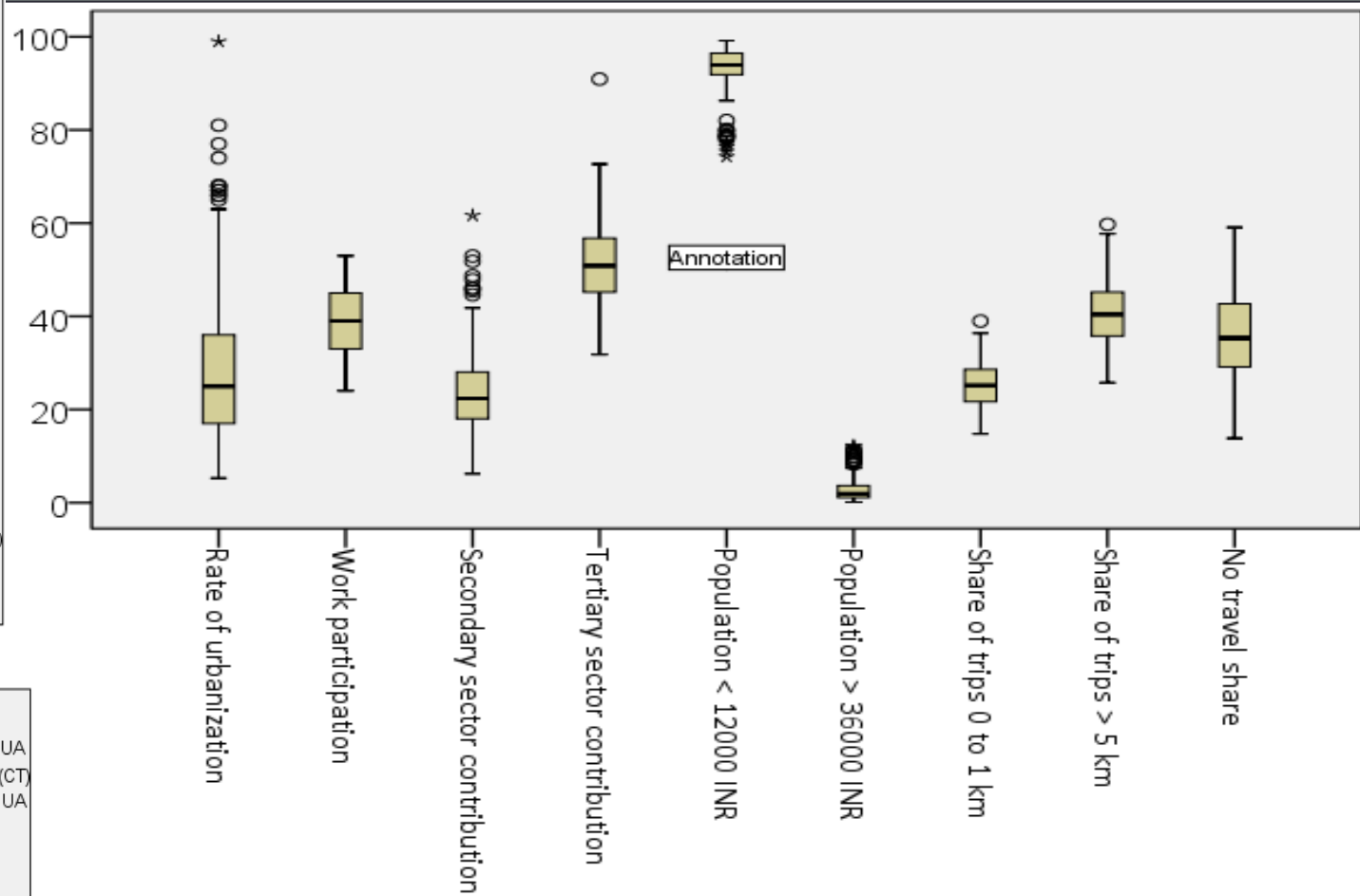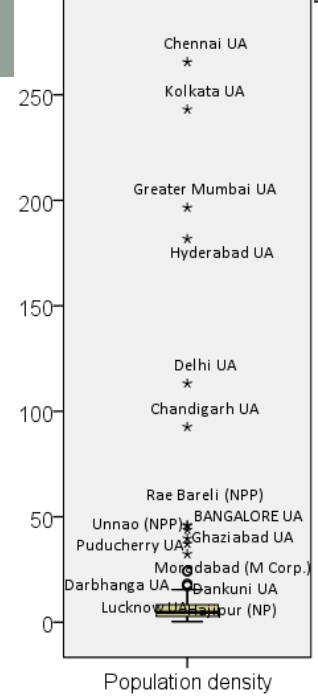Population

ANOVA test
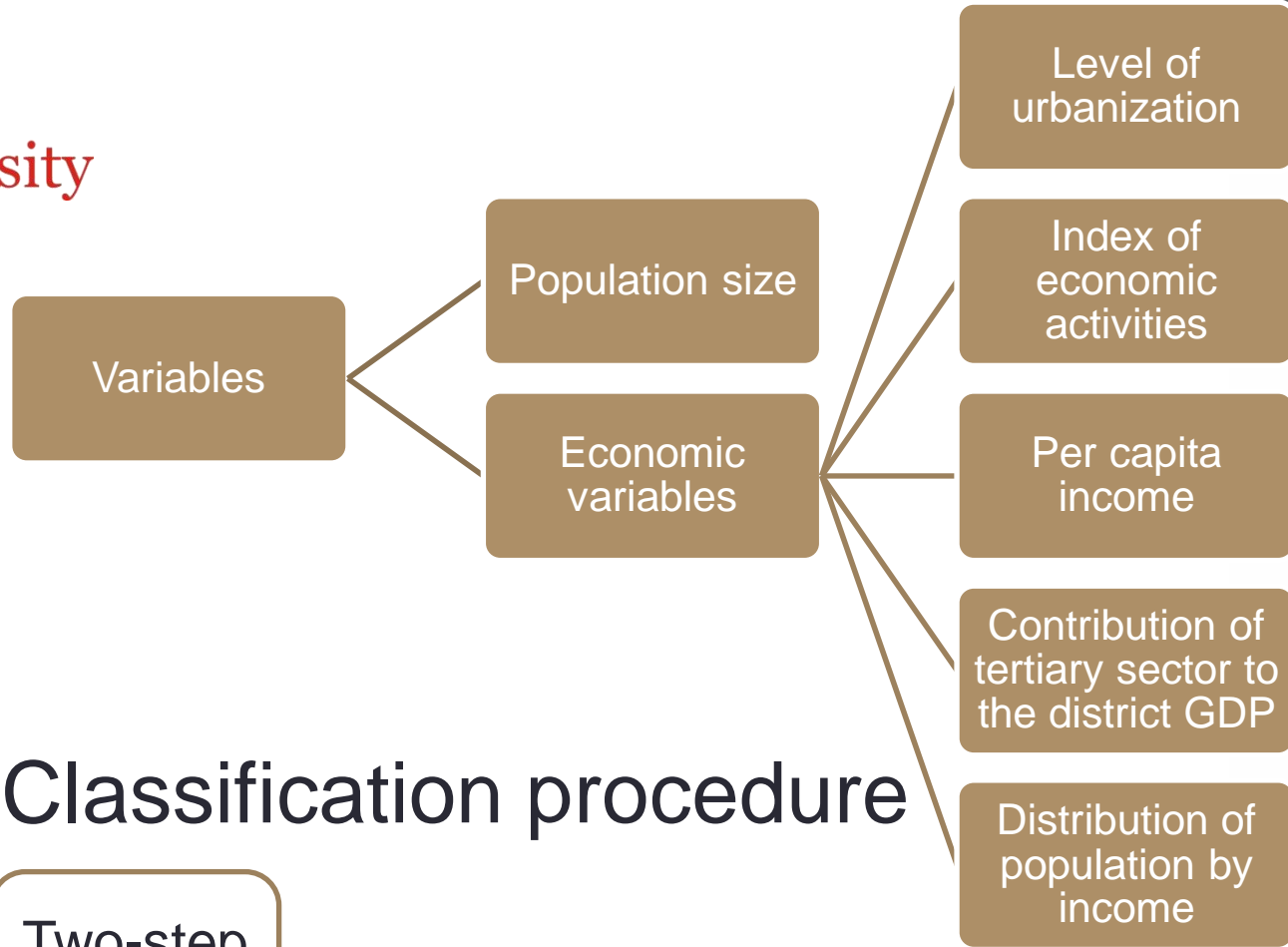
Multi-variate regression analysis

Variables and dataset

- Population density varies between 0.35 persons per ha and 265 persons per ha with mean = 9.31 persons per ha and s = 24.74 persons per ha
- Index of economic activities with mean of 0.209 and standard deviation of 1.131.
- 'No travel' share ranges between 10% and 59% with mean of 33% and standard deviation of 9%

Bi-variate correlation analysis

	Population density	Per-capita income	Index of economic activities	Contribution of secondary sector to district GDP	Contribution of tertiary sector to district GDP	percentage urban population
Population density	1					
Per-capita income		1				
Index of economic activities	.563	.215	1			
Contribution of secondary sector to district GDP		.287		1		
Contribution of tertiary sector to district GDP	.353	.271	.232	-.327	1	
Income < INR 12000 per month	-.307	-.514	-.361	-.262	-.227	-.594
Income between INR 12000 – 36000 per month	.329	.460	.331	.212	.278	.578
Income > INR 36000 per month	.257	.540	.375	.303	.158	.574
Percentage urban population	.445	.511	.330	.307	.464	1
Work participation rate	-.152	.178				

Classifying districts

Classification procedure

Variables
- Population size
- Economic variables
  - Level of urbanization
  - Index of economic activities
  - Per capita income
  - Contribution of tertiary sector to the district GDP
  - Distribution of population by income
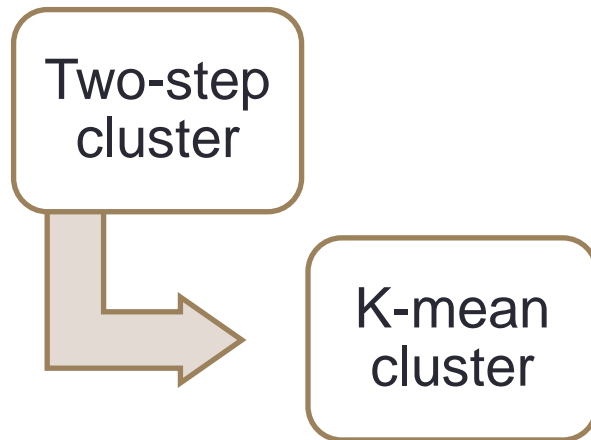
Two-step cluster → **K-mean cluster**

Model Summary

Algorithm	TwoStep
Inputs	1
Clusters	3

Cluster Quality

Silhouette measure of cohesion and separation
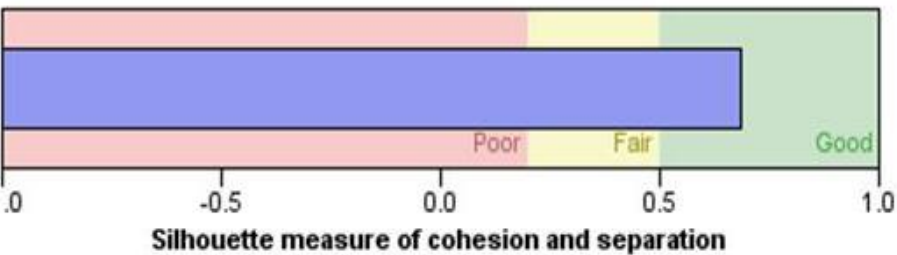
Two-step cluster classification for population

Model Summary

Algorithm	TwoStep
Inputs	7
Clusters	2

Cluster Quality

Silhouette measure of cohesion and separation
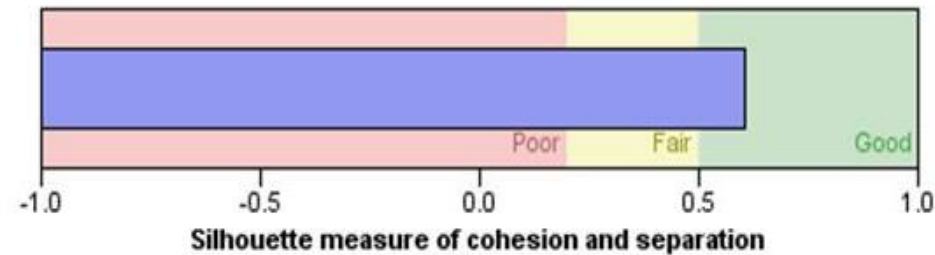
Two-step cluster classification for correlated variables

Cluster classifications – type 1 Based on population

Cluster No.	Valid cases	Statistics			
		Mean (in millions)	Std. Deviation (in millions)	Minimum (in millions)	Maximum (in millions)
Large	6	10.77	3.14	7.72	16.79
Medium	119	3.86	0.88	2.80	7.21
Small	234	1.71	0.58	0.24	2.77
Totals	359				

Cluster classifications – type 2
Based on socio-economic variables

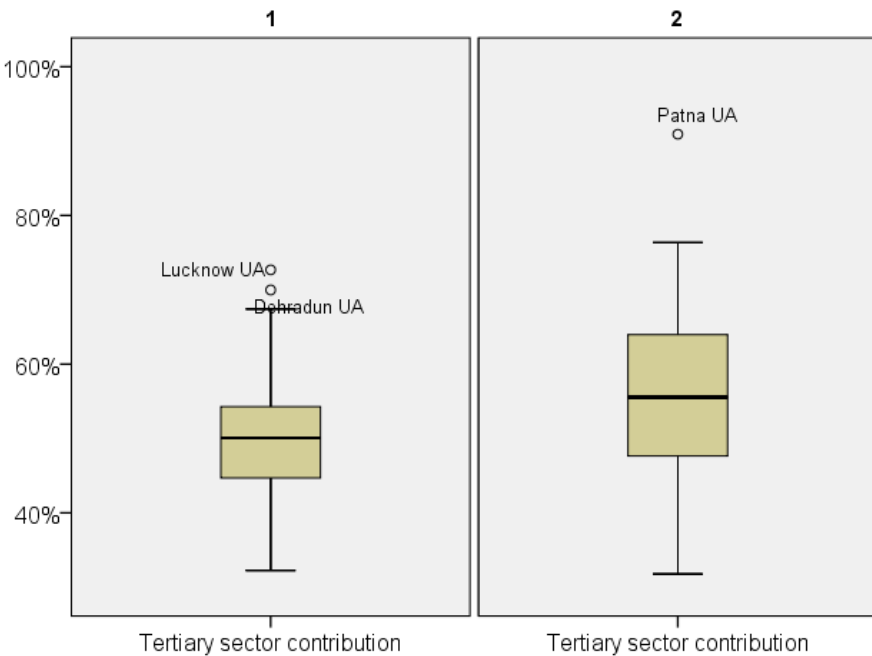| Cluster Number of Case	Cluster classification	N	Mean	Std. Deviation	Minimum	Maximum
Tertiary sector contribution	1	166	50%	8%	32%	73%
	2	66	56%	11%	32%	91%
Per-capita income (INR)	1	166	19403	8263	6122	35066
	2	66	51399	14776	35713	95373
Index of economic activities (2007)	1	166	.078	.085	.008	.525
	2	66	.615	2.462	.020	19.811
Percentage of population in urban	1	166	24%	14%	5%	99%
	2	66	43%	19%	17%	100%
Population density (per hectare)	1	166	693	706	35	4608
	2	66	934	2418	48	19652
Percentage of population with income < INR 12,000	1	166	95%	27%	82%	99%
	2	66	88%	72%	59%	97%
Percentage of population with INR 12,000 - 36,000	1	166	3%	2%	6%	11%
	2	66	7%	4%	2%	22%

Cluster Number of Case

1	2

Tertiary sector contribution — Tertiary sector contribution

Lucknow UA, Dehradun UA (cluster 1); Patna UA (cluster 2)

Cluster Number of Case

1	2

percentage of population in urban — percentage of population in urban

Srinagar UA; Ghaziabad UA, Gwalior UA, Lucknow UA, Kanpur UA, Jamshedpur UA, Dehradun UA, Jhunjhunun (M Cl) (cluster 1); Greater Mumbai UA (cluster 2)

Cluster Number of Case

1	2

Per-capita income — Per-capita income

Kozhikode UA, Thrissur UA, Palakkad UA, Kochi UA, Kasaragod UA, Navi Mumbai Panvel Raigad (CT) (cluster 2)

Cluster Number of Case

1	2

Population density per hectare — Population density per hectare

Unnao (NPP), Rae Bareli (NPP), Moradabad (M Corp.), Ghaziabad UA, Varanasi UA (cluster 1); Greater Mumbai UA, BANGALORE UA, Patna UA (cluster 2)

Correlation between socio-economic factors and trip length frequency distribution

	No travel	Trips between 0 - 1 km	Trips > 5 km
Cluster type 1(1 = large, 2 = medium and 3 = small)		0.258	-0.226
Cluster type 2 (1 = low economic, 2 = high economic)	-0.533		0.480
Contribution of secondary sector to district GDP	-0.341	-0.202	0.435
Percentage of total workers	-0.288	0.255	
Population density		-0.121	0.253

Dependent variables	Model summary			Anova		
	R Square	Adjusted R Square	Root MSE	df	F	Sig.
No travel share	0.451	0.436	0.069	6, 225	30.74	0.000
				6		

Regression analysis and results

	Coefficients		
	No travel share	Share of trips TL < 1 km	Share of trips TL > 5 km
Secondary sector contribution	-0.322	-0.053	0.262
Work participation rate	-0.353	0.134	0.045
Population density	0	0	0.001
Cluster type 1 (base= large)			
Medium	0.067	-0.012	-0.084
Small	0.069	0.007	-0.114
Cluster type 2 (base =2)			
1	0.087	0.001	-0.052
Constant	0.444	0.119	0.317

- No travel share is more in districts of small size, less urbanization rate, tertiary sector contribution to the district GDP and per capita income.
- Share of short trips does not varies significantly with population size, population density and economic performance of the districts.
- Share of long distance trips is likely to increase with population size, secondary sector contribution to the district GDP and work participation

Findings and Conclusions

- Travel behavior has been analysed for multiple districts in India
- Trip length frequency distribution can be significantly explained by –
  - economic, socio-economic and development related variables
- Increasing population size of Indian districts is resulting in increasing share of long distance trips.
- Small size districts are likely to have more mix land use intensity thereby explaining high share of no travel
- Share of Short distance trips cannot be explained by the population size of districts.
- Policy implications for sustainable transport policy
  - Adoption of appropriate development policies to discourage long distance trips in large size districts
  - High economic performance of districts is associated with long distance trips – need for appropriate PT infrastructure
  - Adoption of NMT and development policy to retain the existing share of short distance trips

Limitations and way forward

- Limitations
  - Dataset ranges between 2007 – 2010
  - Of the total 361 districts identified complete data is available for only 232 districts
- Future research
  - Need to explore the underlying pattern in modal share
  - The impact of number of employees by establishment type, transport infrastructure availability and vehicle ownership also need to be studied.

THANK YOU