HIGH-RESOLUTION STATEWIDE SOCIO-DEMOGRAPHIC, LAND USE AND ECONOMIC DEVELOPMENT FRAMEWORK FOR TRANSPORTATION PLANNING

NAVEEN ELURU

Professor in Civil, Environmental and Construction Engineering

University of Central Florida

SEFL FSUTMS Users Group Presentation, July 11, 2024

- Research Overview
- Project Vision
- Project Findings
- Conclusion

RESEARCH OVERVIEW

- Build choice/econometric models for understanding behavioral processes
- Draw on econometrics, data analytics, optimization and micro-simulation
- Focus on explainable data analysis approaches to predict the decision processes into the future
- Incorporate these advances within quantitative frameworks to study the influence of individuals, households, firms, and communities
- The quantitative frameworks have application in transportation and multiple inter-disciplinary areas

RESEARCH OVERVIEW

Safety

- High-resolution (parcel level) land use evolution to pro-actively address safety challenges of the future [FDOT]
- Incorporating vehicle mix in roadway crash frequency and severity across rural and urban roadway facilities [NCHRP 22-49]

Resilience

- Improving economic resiliency by understanding the impact of disasters (floods and hurricanes) and sea-level rise on land use changes and property values
- Mobility modeling and economic recovery pre-disaster, during disaster and post-disaster using emerging data sources

Mobility

- Incorporating emerging mobility options (CAVs, TNCs, shared mobility) in travel demand models [NCHRP 20-102(29)]
- Using emerging data sources for seasonal population synthesis module within the Florida Statewide Travel Demand Model

I will focus on a FDOT project "Development of a high-resolution statewide socio-demographic, land use and economic development framework for transportation planning"

6

HIGH-RESOLUTION STATEWIDE SOCIO-DEMOGRAPHIC, LAND USE AND ECONOMIC DEVELOPMENT FRAMEWORK

BACKGROUND

- The current project focuses on developing a standardized high resolution state-wide sociodemographic, land use and economic development model
- The project will generate a universal template of variables that will be useful for the statewide framework
- For the universal template built, the research team will generate socio-economic, land use and economic development variables

OBJECTIVES

- To establish a universal template of socio-demographic, land use and economic indicators
- To develop and validate an algorithm to generate socio-demographic, land use and economic indicators
- To employ the validated algorithm developed to generate future socio-demographic, land use and economic indicators in 5-year increments from 2025 through 2050
- To generate the variables for a spatial resolution that can be directly employed for local jurisdictions and statewide models

RESEARCH APPROACH

- Review of current state of the art
- From the review, we attempted to answer the following questions:
  - What are the output variables?
  - What are the spatial resolutions?
  - How are the variables being predicted?
  - What are the independent variables?
  - How can the models guide our framework development?
  - How can we address the data requirements?
- Stakeholder survey

REVIEW SUMMARY

	UrbanSIM	FLUAM	LandSys	ILUMASS	SLEUTH
Modeling Approach	Microsimulation Approach	Statistical Modeling Approach	Microsimulation Approach	Microsimulation Approach	Simulation
Spatial Resolution	Grid Level	TAZ Level	Grid Level	Grid level	Grid level
Time step	1 year	5 years	1 year	1 year	1 year
Forecast Year	Flexible by study region	2045	2025	2030	N/A

REVIEW SUMMARY

	UrbanSIM	FLUAM	LandSys	ILUMASS	SLEUTH
Output Variables	• HH and Employment Location Change • Developers' Choices of New Development • Land Price • Local and Regional Accessibility	• Land Development Decision • HH and Employment Density	• Spatial distribution of households and employment	• Household demographics • Employment information • Household and employment distribution	• Urban growth
What is Missing?	• Demographics • Economic Development Variables	• Demographics • Economic Development Variables	• Demographics • Economic Development Variables	• Economic development variables	• Demographics • Economic development variables

STAKEHOLDER SURVEY

- To design the survey questions, we first prepare a list of socio-demographic, land use and economic development variables
- The variables are selected based on the review of existing travel demand models
- In pairwise comparison method, variable group pairs will be assigned with a relative weight
- Next, respondents will be requested to choose important variables within each variable group
- In this study, we will employ pairwise comparison method for weighting three variable groups

VARIABLE LIST

Sociodemographic	Land Use	Economic Development
• Population • Number of households • Age distribution • Gender distribution • Race • Number of children • School enrollment • Educational Status • Vehicle ownership	• Land use diversity variable • Residential area • Business center density • Institutional area • Roadway density • Bike lane density • Sidewalk density • Bus station and network density • Number of hotel/motels	• Median income • Employment • Retail employment density • Average number of workers per household • Retail density • Shopping center density

SAMPLE SURVEY QUESTIONS

Before you begin, please read the following paragraph carefully.

Toward evaluating usefulness of input variables, scoring/ranking them is a useful step. In our research, three groups of variables have been considered. These three groups considered are presented below:

(1) **Socio-demographic variables:** Population, Number of households, Age distribution, Gender, Number of children, School enrollment and Vehicle ownership

(2) **Land use characteristics:** Land use mix/diversity variable, Recreational area and Number of hotel/motels

(3) **Economic development indicators:** Median income, Employment, Average number of workers per household, Retail/shopping center density

Previous

Next

SURVEY QUESTIONS

In this study, we intend to adopt a 'Pairwise Comparison' method for scoring variable groups. In this approach, we compare variable group A with variable group B on a reciprocal numerical rating scale ranging from 1/9 (extreme preference for group B) to 9 (extreme preference for group A). Numerical scale for preference rating is given below:

Preference rating	Definition
1	Equal importance
2	Weak or slightly important
3	Moderate importance
4	Moderate plus
5	Strong importance
6	Strong plus
7	Very strong
8	Very, very strong
9	Extreme importance

Previous

Next

SURVEY QUESTIONS

For example, variable group A has moderate preference over variable group B. As a result, decision-maker can assign a numerical score 3 to A compared to B. According to this methodology, preference rating of B compared to A will be reciprocal of 3. A demonstration of pairwise relationships for three variable groups is provided in following table:

Variable Group	Socio-demographics	Land use	Economic development
Socio-demographics	1	3	4
Land use	1/3	1	2
Economic development	1/4	1/2	1

Overall weights for the variable groups can be computed from processing the pairwise comparison matrix above.

Previous

Next

SURVEY QUESTIONS

1. Provide a relative score for "socio-demographic variables" (between 1/9 and 9) compared to land use and economic development variables.

	Land use	Economic development
Demographics		

2. Provide a relative score for "land use variables" (between 1/9 and 9) compared to economic development variables.

	Economic development
Land use	

Previous

Next

SURVEY QUESTIONS

2. Please choose important land use variables for transportation planning models from the following list:

- ○ Land use mix
- ○ Land use diversity variable
- ○ Residential area
- ○ Industrial area
- ○ Institutional area
- ○ Recreational area
- ○ Number of hotel/motels
- ○ Other (specify)

SURVEY QUESTIONS

3. Please choose important economic development variables for transportation planning models from the following list:

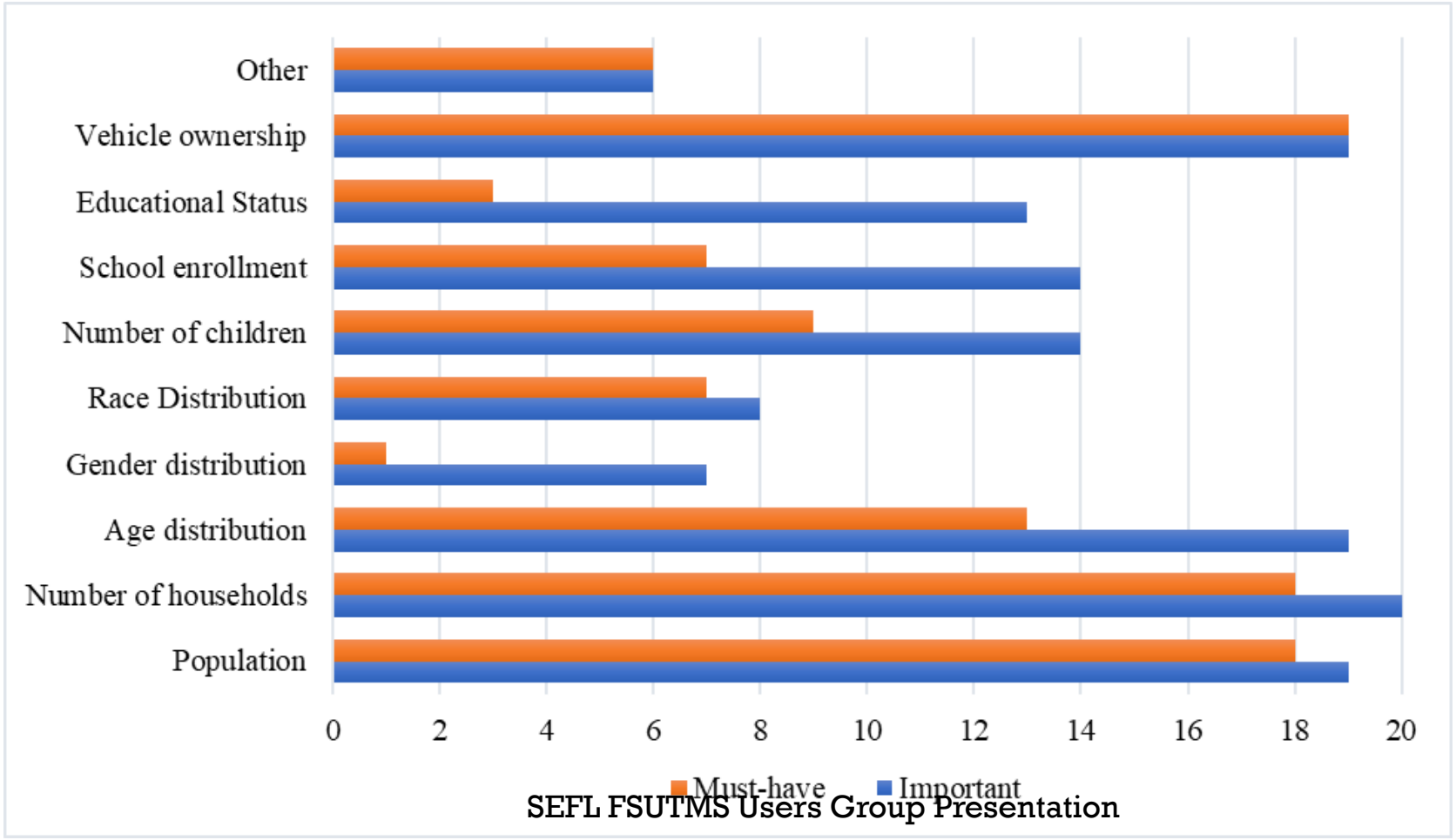
- ○ Median income
- ○ Employment
- ○ Employment density
- ○ Average number of workers per household
- ○ Retail density
- ○ Shopping center density
- ○ Other (specify)

SURVEY RESULTS

Variable Groups	Socio-demographic	Land use	Economic development
Socio-demographic	1.00	3.29	4.00
Land use	0.30	1.00	3.96
Economic development	0.25	0.25	1.00

Variable Groups	Socio-demographic	Land use	Economic development	Priority	Ranking
Socio-demographic	0.64	0.72	0.45	1.81	1
Land use	0.20	0.22	0.44	0.86	2
Economic development	0.16	0.06	0.11	0.33	3

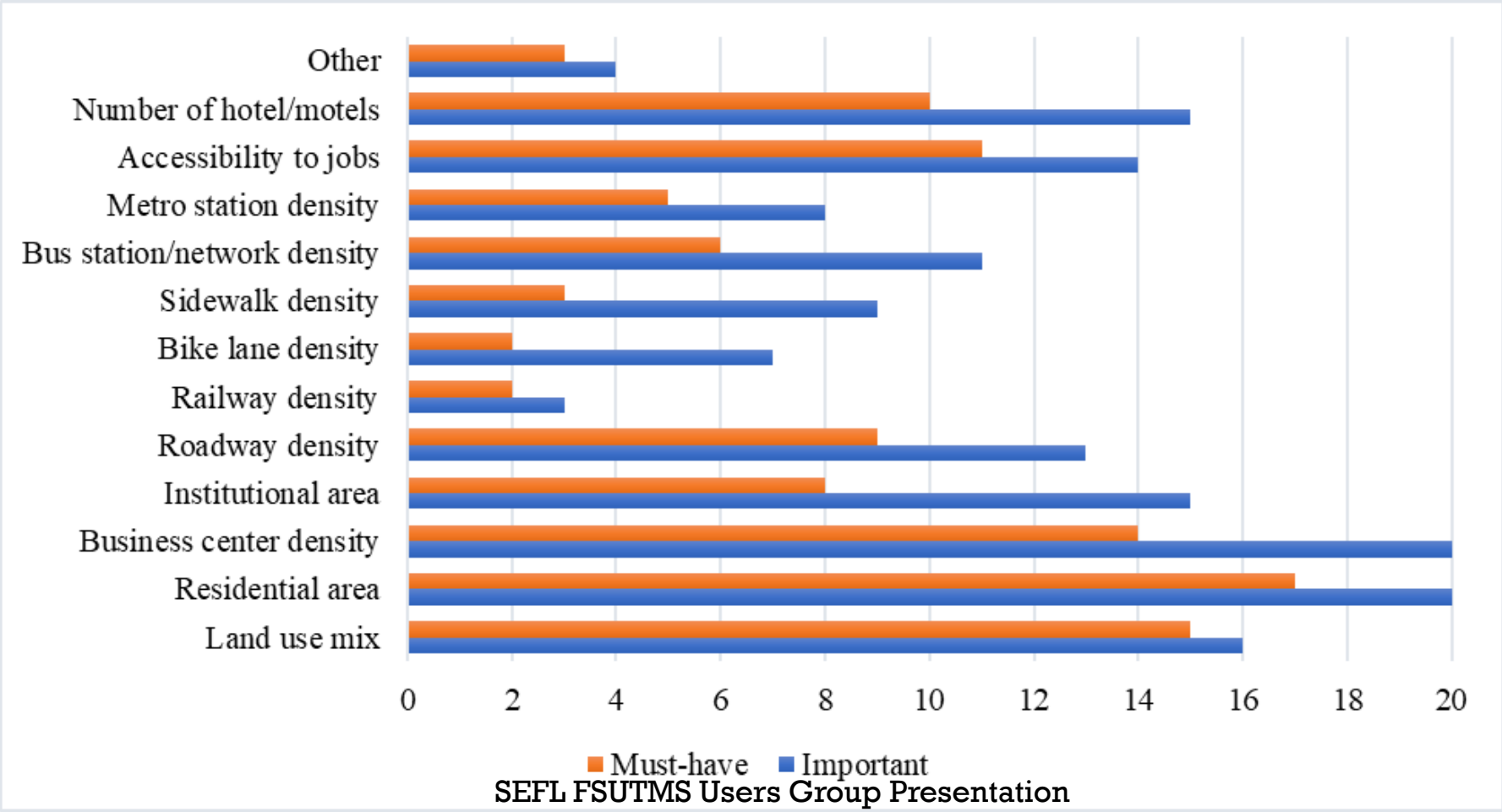
SOCIODEMOGRAPHIC VARIABLES



SOCIODEMOGRAPHIC VARIABLES

- The following sociodemographic variables are recommended by the stakeholders:
  - Employment status
  - Employment type
  - Long term visitors
  - Income (already considered among economic development variables)

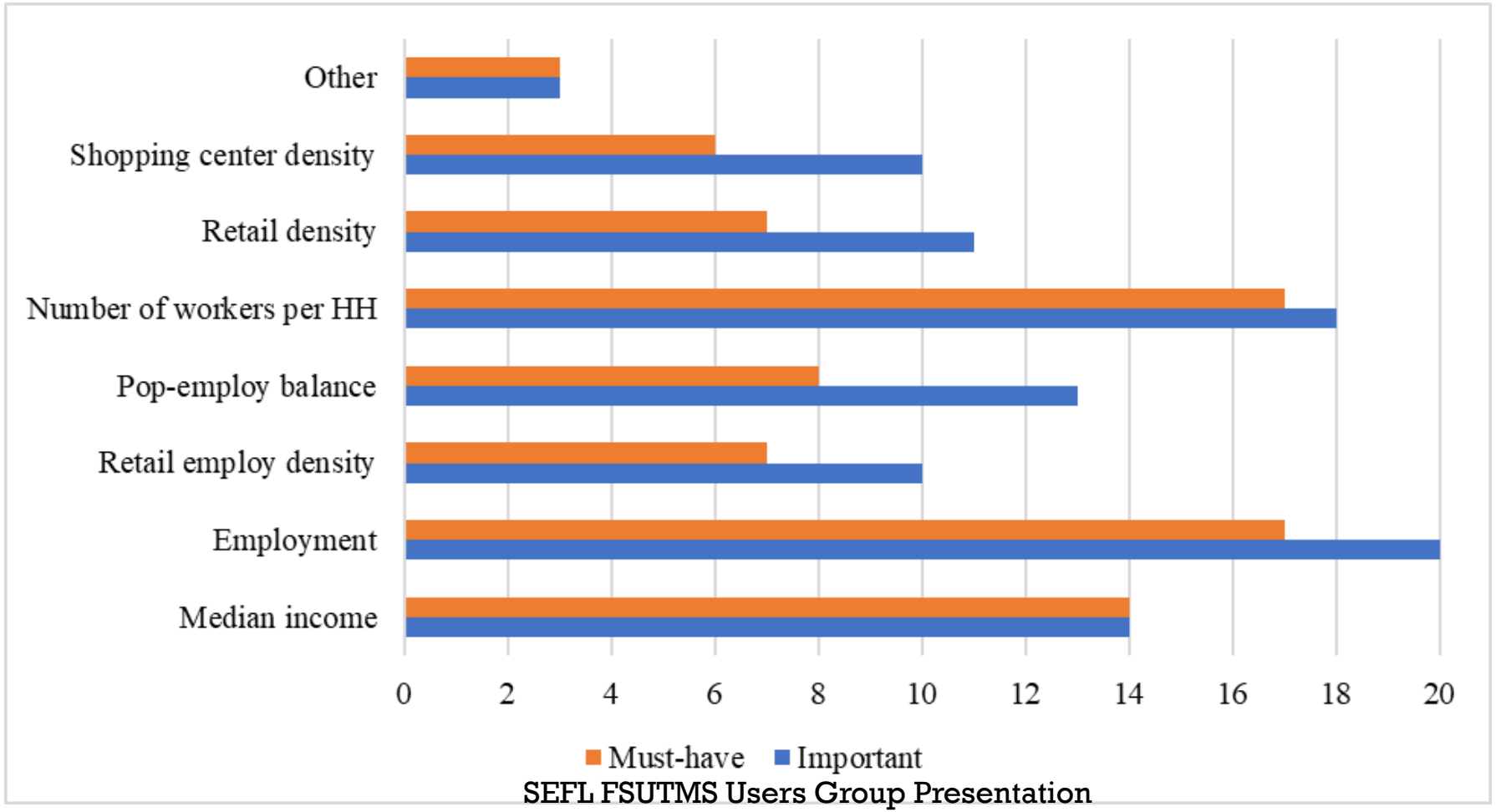
LANDUSE VARIABLES



LANDUSE VARIABLES

- The following land use variables are recommended by the stakeholders:
  - Recreational area
  - Entertainment area
  - Parking
  - Walkability index
  - Land use plan designation
  - Transit-oriented developments
  - Accessibility to multimodal systems
  - Core employment versus core residential connectivity
  - Undevelopable land

ECONOMIC DEVELOPMENT VARIABLES



ECONOMIC DEVELOPMENT VARIABLES

- The following economic development variables are recommended by the stakeholders:
  - Population vs. employment growth index for each zone/area type
  - Multimodal integration for better accessibility to employment
  - Demand management integration for congestion mitigation improving regional access
  - Regional connection of metropolitan areas
  - Jobs by NAICS category

DATA PREPARATION

DATA SOURCES

Data Sources	Variables
U.S. Census Bureau and American Community Survey	Population, number of households, gender distribution, age distribution, poverty, school enrollment, educational attainment, race, vehicle ownership level, median income, total number of business establishment, number of jobs
Florida Department of Revenue	Land use type, distance to the nearest road, percentage of different land use types, land use mix/land use diversity variable, number of hotel/motel, number of stores and supermarkets and number of shopping centers
FDOT Roadway Characteristics Inventory and Florida Geographic Data Library	Road density, sidewalk density, bike lane density, bus stop and bus route density

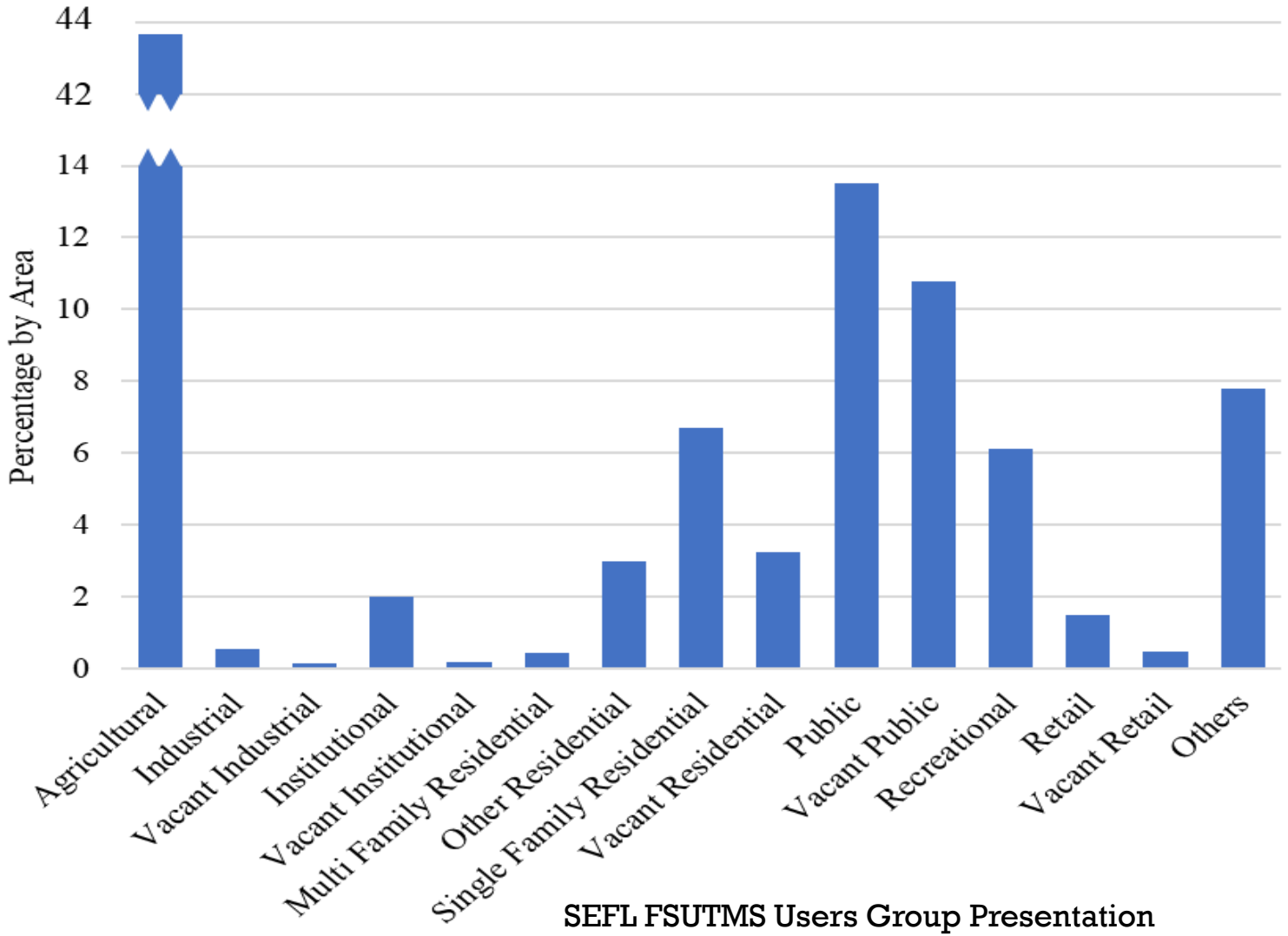
SPATIAL RESOLUTIONS

Spatial Resolutions	Variables
Parcel	Land use type, distance to the nearest road from a parcel
Block Group	*Sociodemographic:* Population, gender distribution, age distribution, poverty, school enrollment and race *Land use:* Percentage of different land use types, land use mix/land use diversity variable, road density, number of hotel/motel, sidewalk density, bike lane density, bus stop and bus route density *Economic development:* Number of stores and supermarkets and number of shopping centers
Census Tract	*Sociodemographic:* Number of households, educational attainment, and vehicle ownership level *Economic development:* Median income
County	*Economic development:* Total number of business establishment and number of jobs

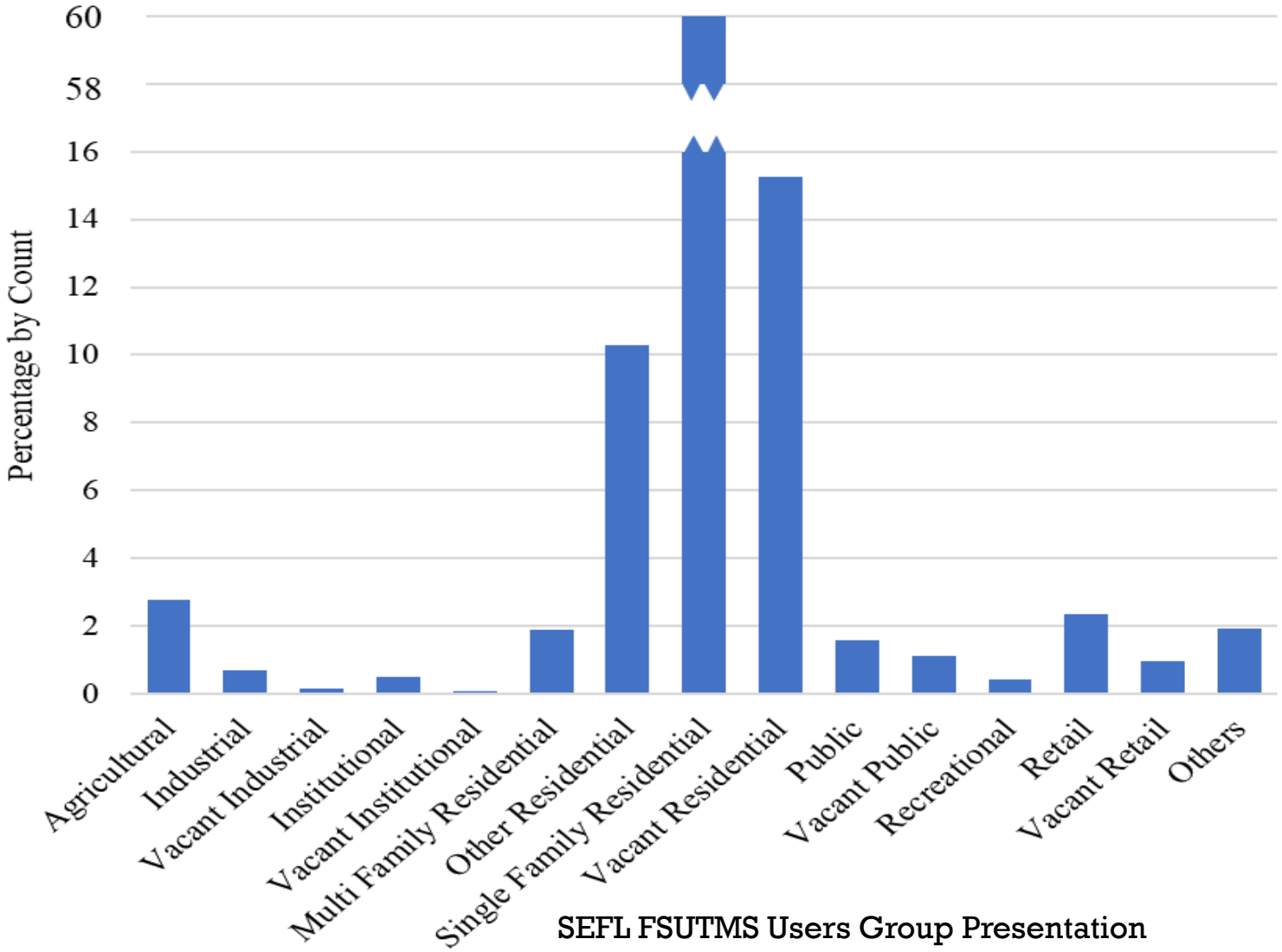
LAND USE CATEGORIES

Land Use Type	DOR_UC Code	Examples
Other Residential	2, 4-7, 9	Mobile Homes, Condominiums, Cooperatives, Retirement Homes not eligible for exemption and Residential Common Elements/Areas
Vacant Residential	0	Vacant Residential – with/without extra features
Public	83, 85-91	Public county schools, Hospitals (non-private), Counties, State, Federal, Municipal
Vacant Public	80	Vacant Governmental - with/without extra features
Recreational	82, 97	Forest, parks, recreational areas and Outdoor recreational or parkland, or high-water recharge
Retail or office	11-39	Stores, Mixed use - store and office, Department Stores, Supermarkets, Office buildings, Airports, Restaurants, Cafeterias
Vacant Retail or office	10	Vacant Commercial - with/without extra features
Others	92-96, 98-100, 995, 999	Mining lands, petroleum lands, or gas lands, Right-of-way, streets, roads, irrigation channel, Rivers and lakes

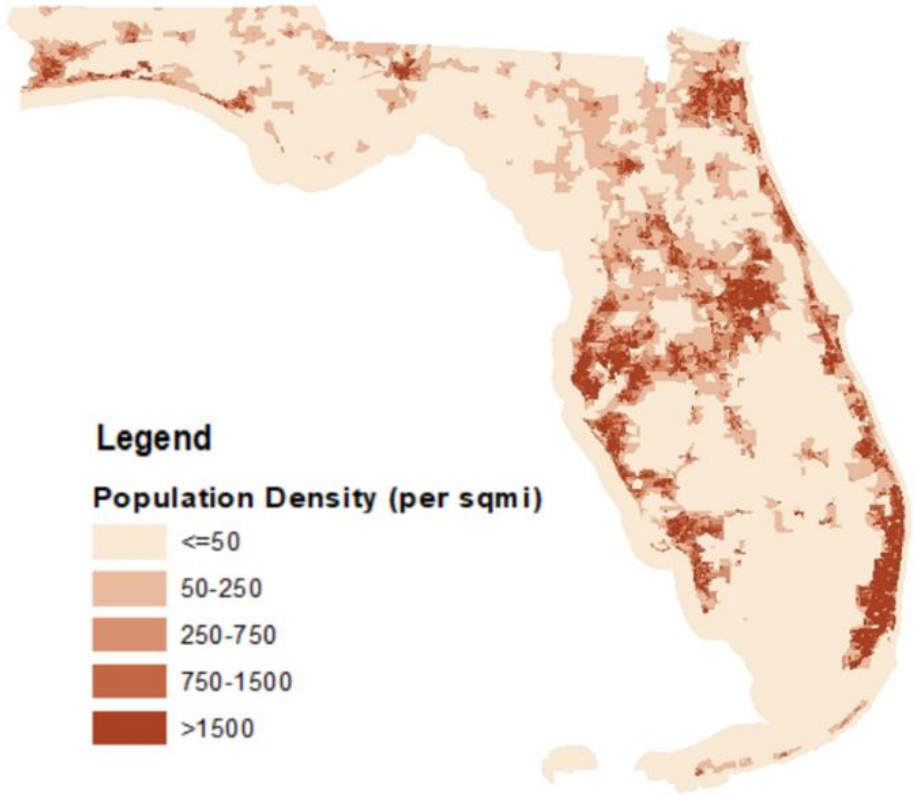
LAND USE DISTRIBUTION

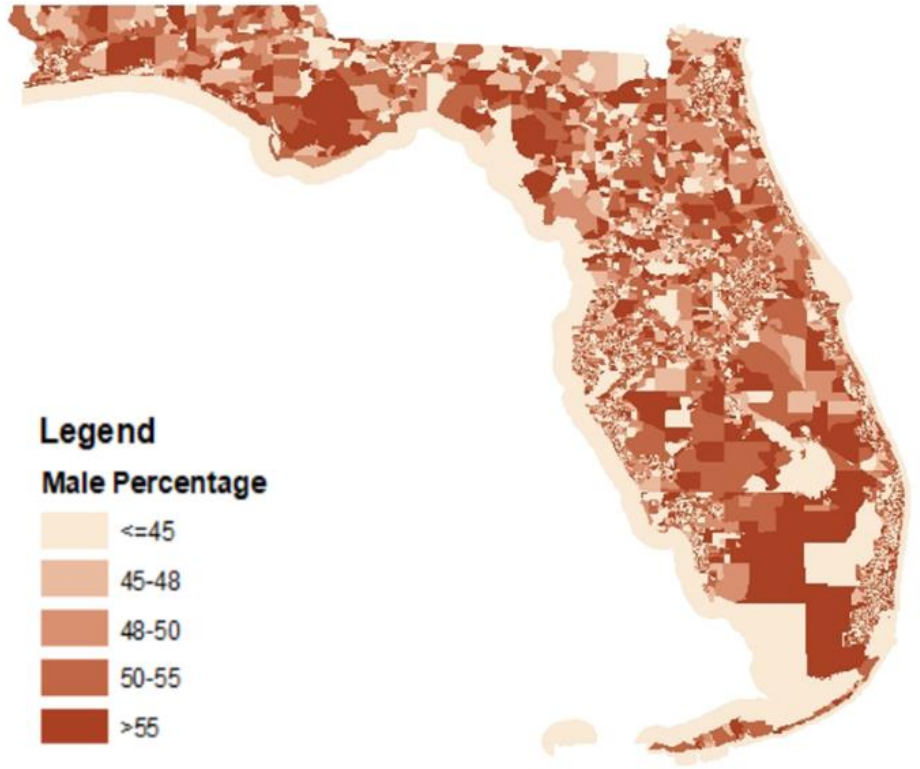


LAND USE DISTRIBUTION

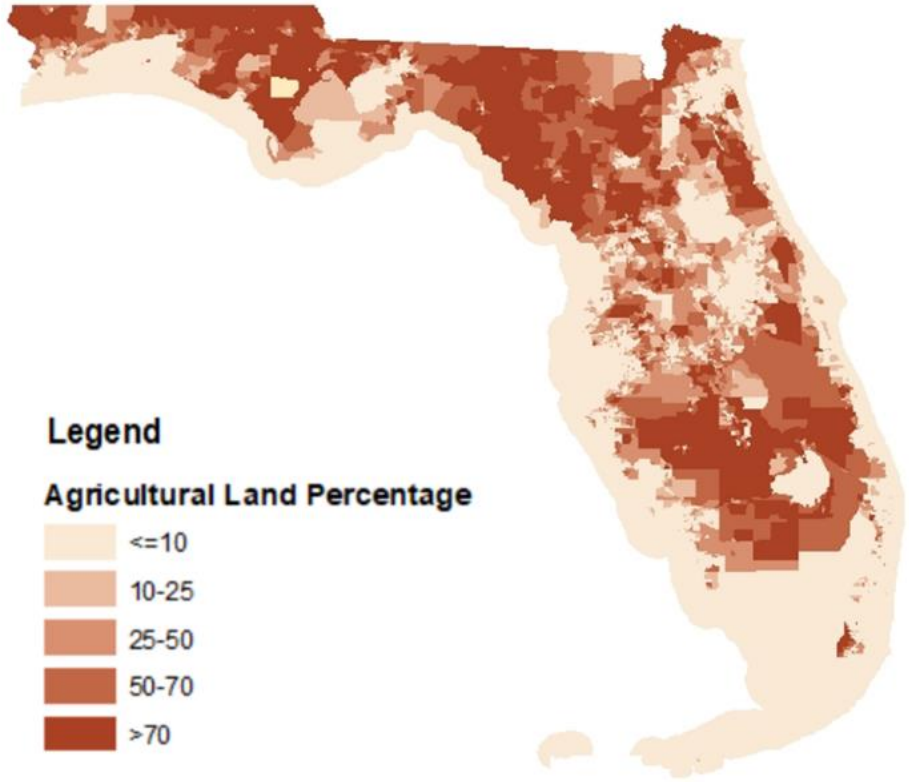


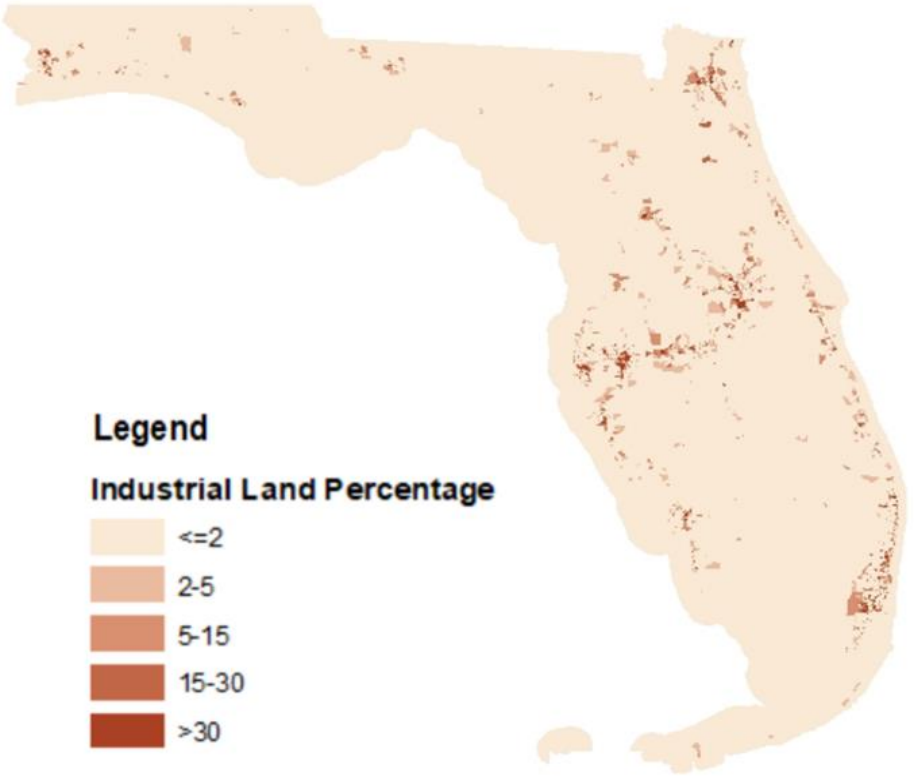
FINDINGS


Legend
Population Density (per sqmi)
<=50
50-250
250-750
750-1500
>1500

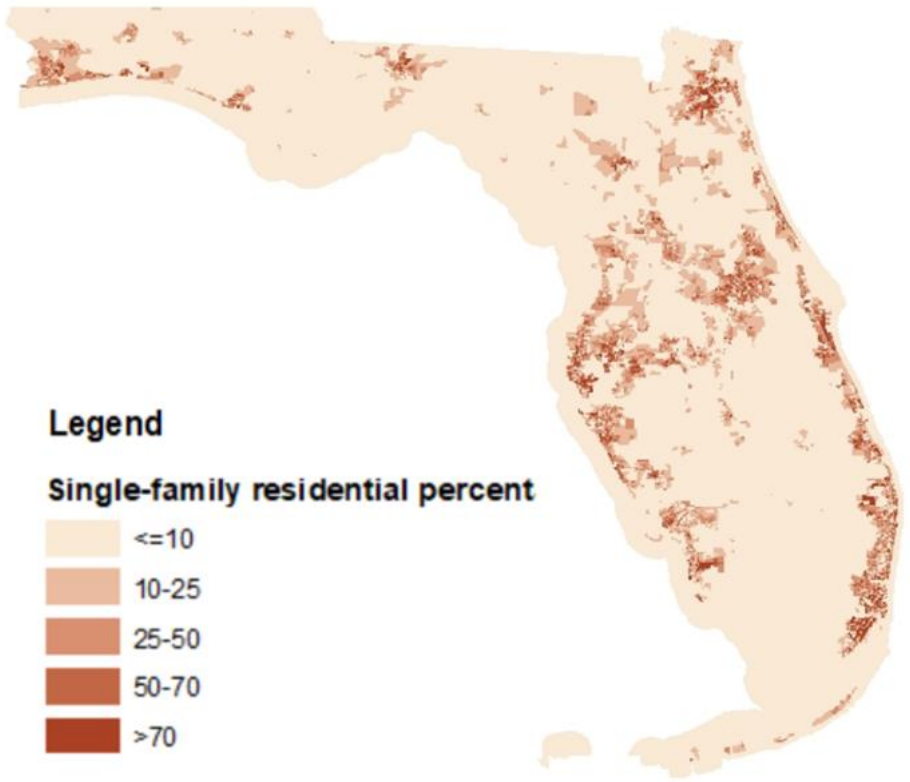

Legend
Male Percentage
<=45
45-48
48-50
50-55
>55

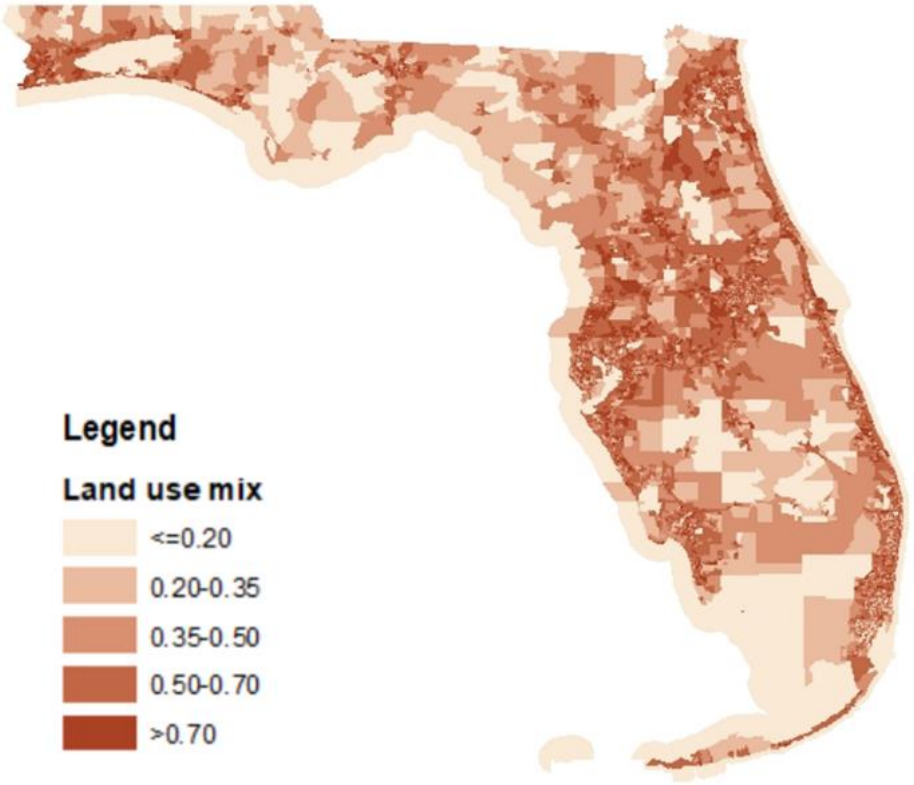
FINDINGS


Legend
Agricultural Land Percentage
<=10
10-25
25-50
50-70
>70

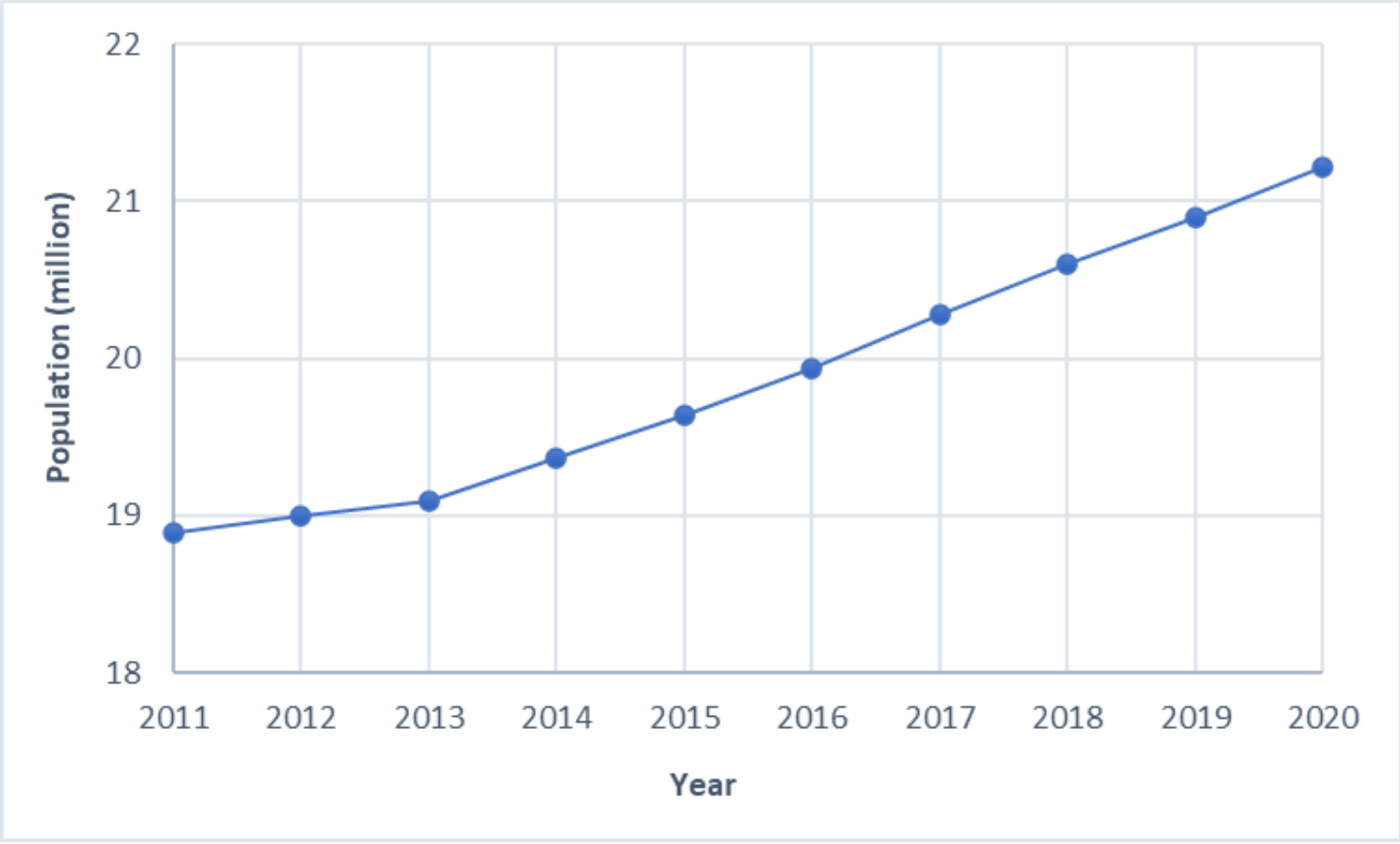

Legend
Industrial Land Percentage
<=2
2-5
5-15
15-30
>30

FINDINGS

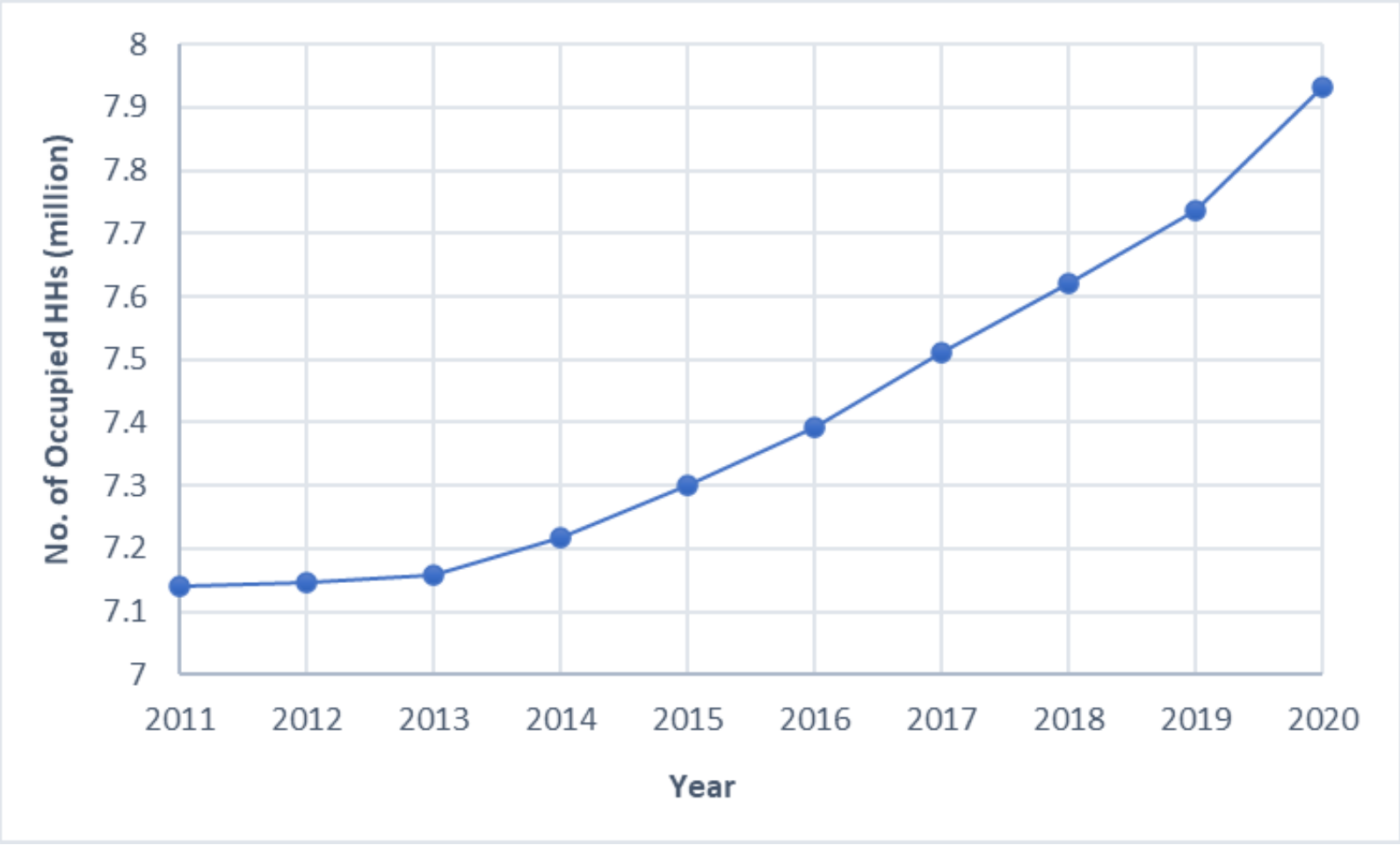

Legend
Single-family residential percent
<=10
10-25
25-50
50-70
>70


Legend
Land use mix
<=0.20
0.20-0.35
0.35-0.50
0.50-0.70
>0.70

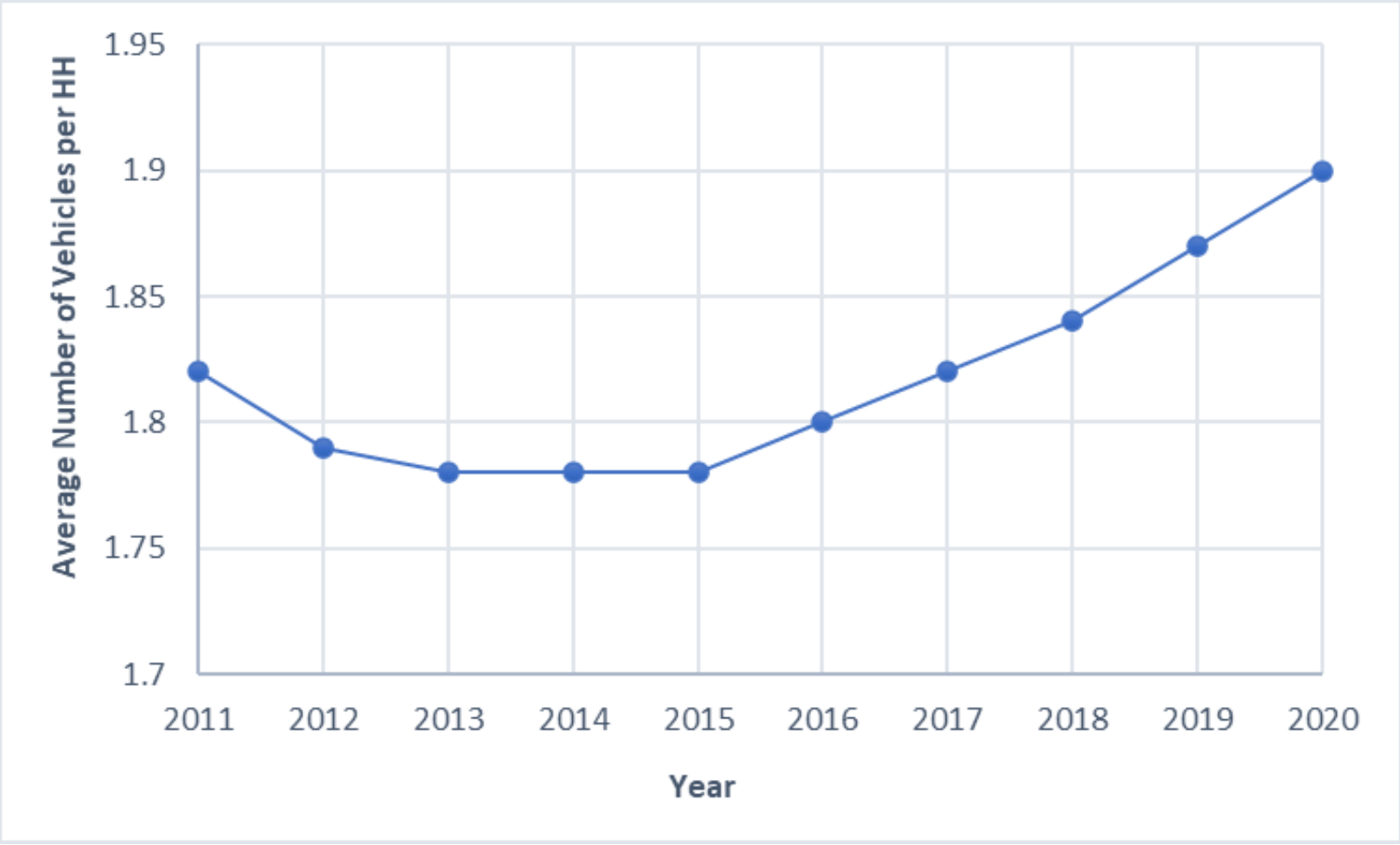
POPULATION


22
21
20
19
18
Population (million)
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Year

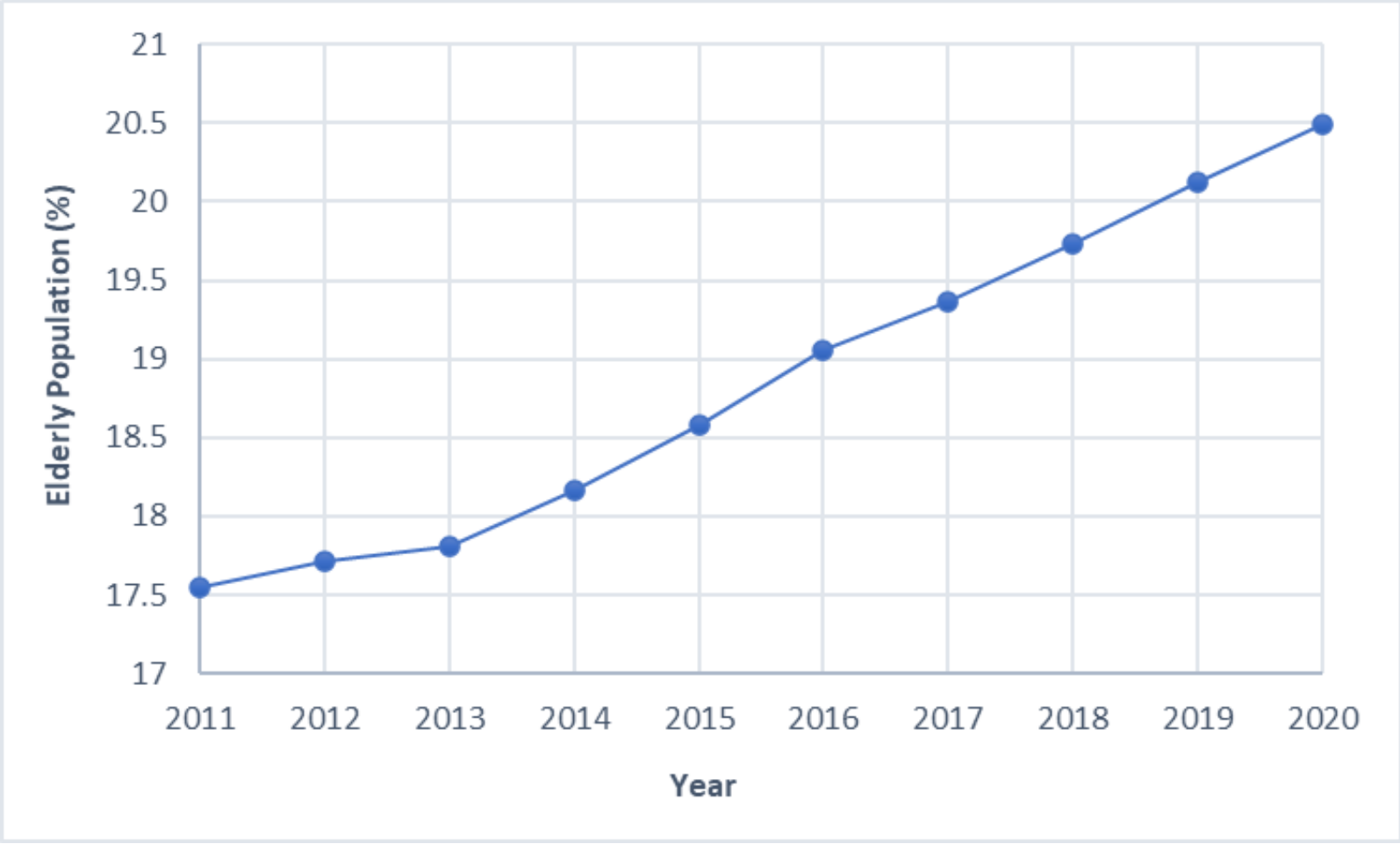
HOUSEHOLDS


No. of Occupied HHs (million)
8
7.9
7.8
7.7
7.6
7.5
7.4
7.3
7.2
7.1
7
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Year

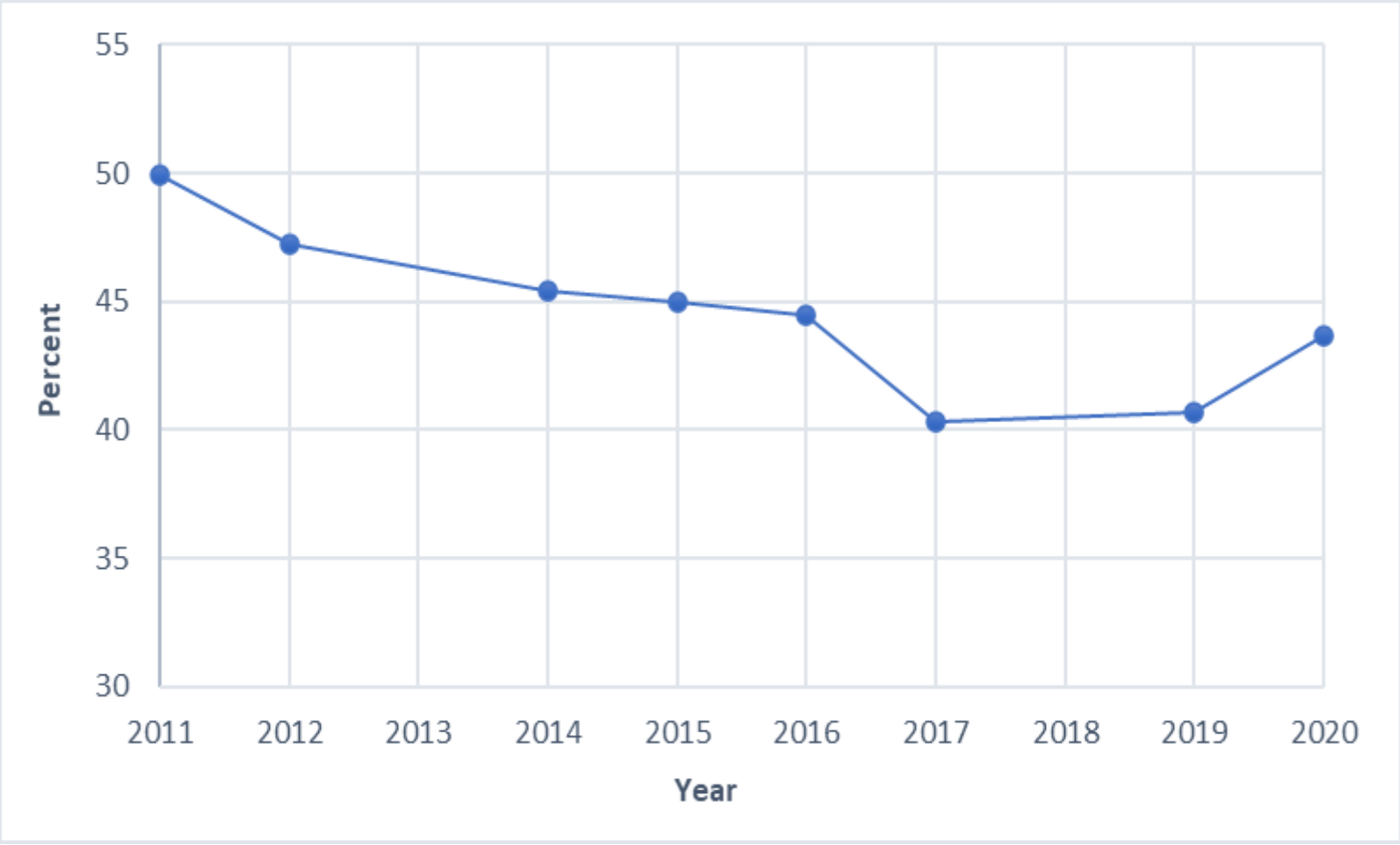
VEHICLE OWNERSHIP



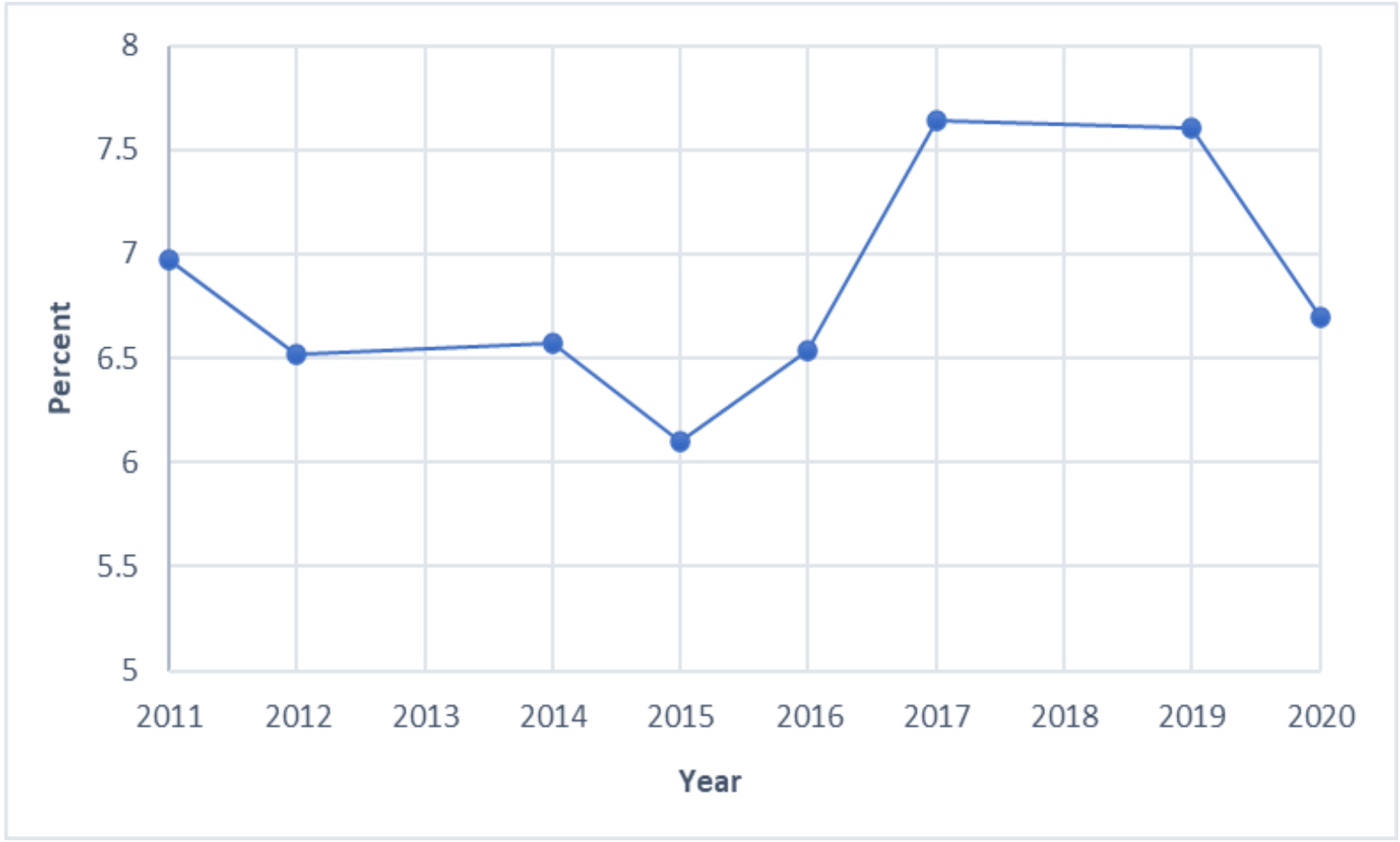
AGE DISTRIBUTION



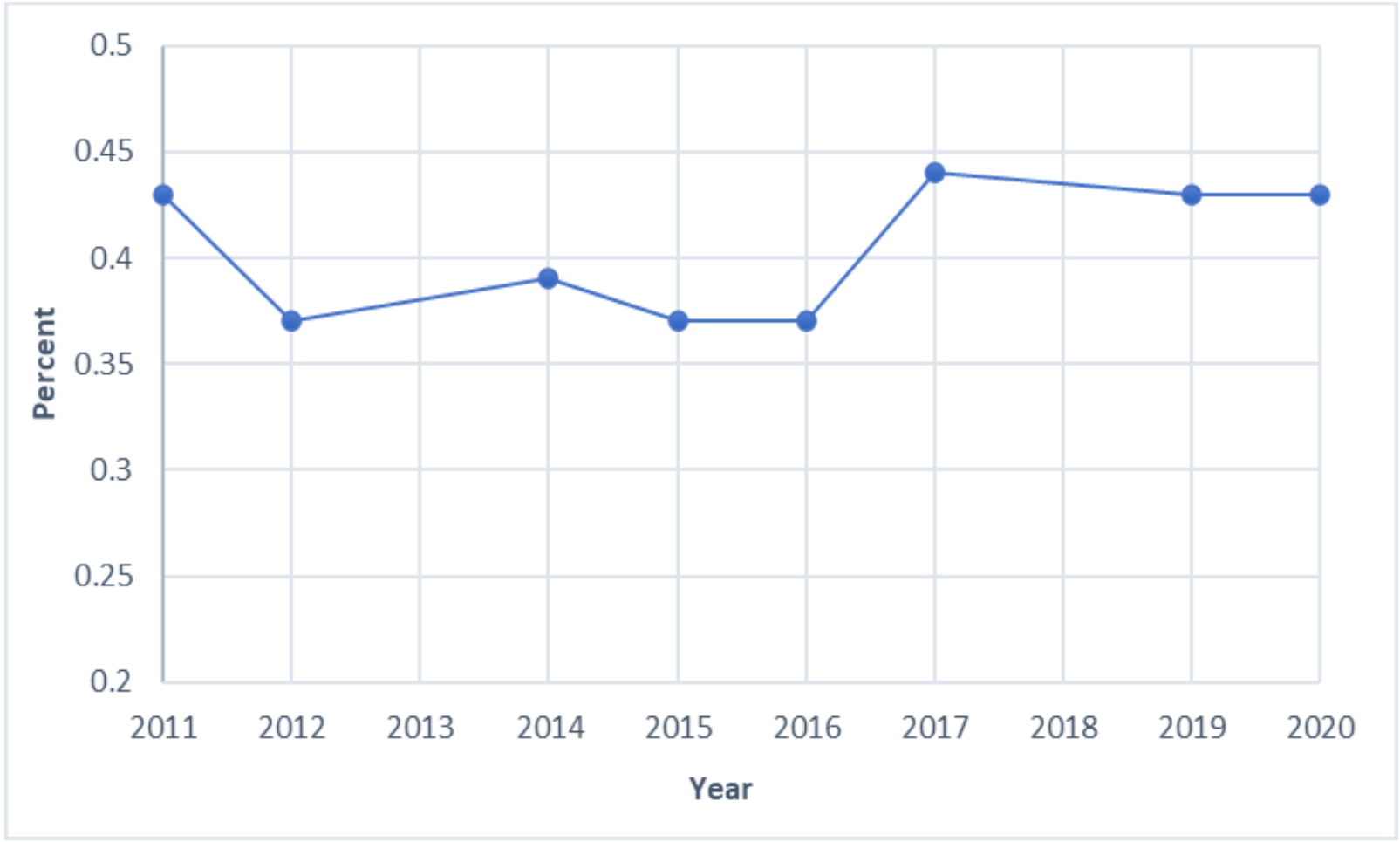
AGRICULTURAL LU PERCENT



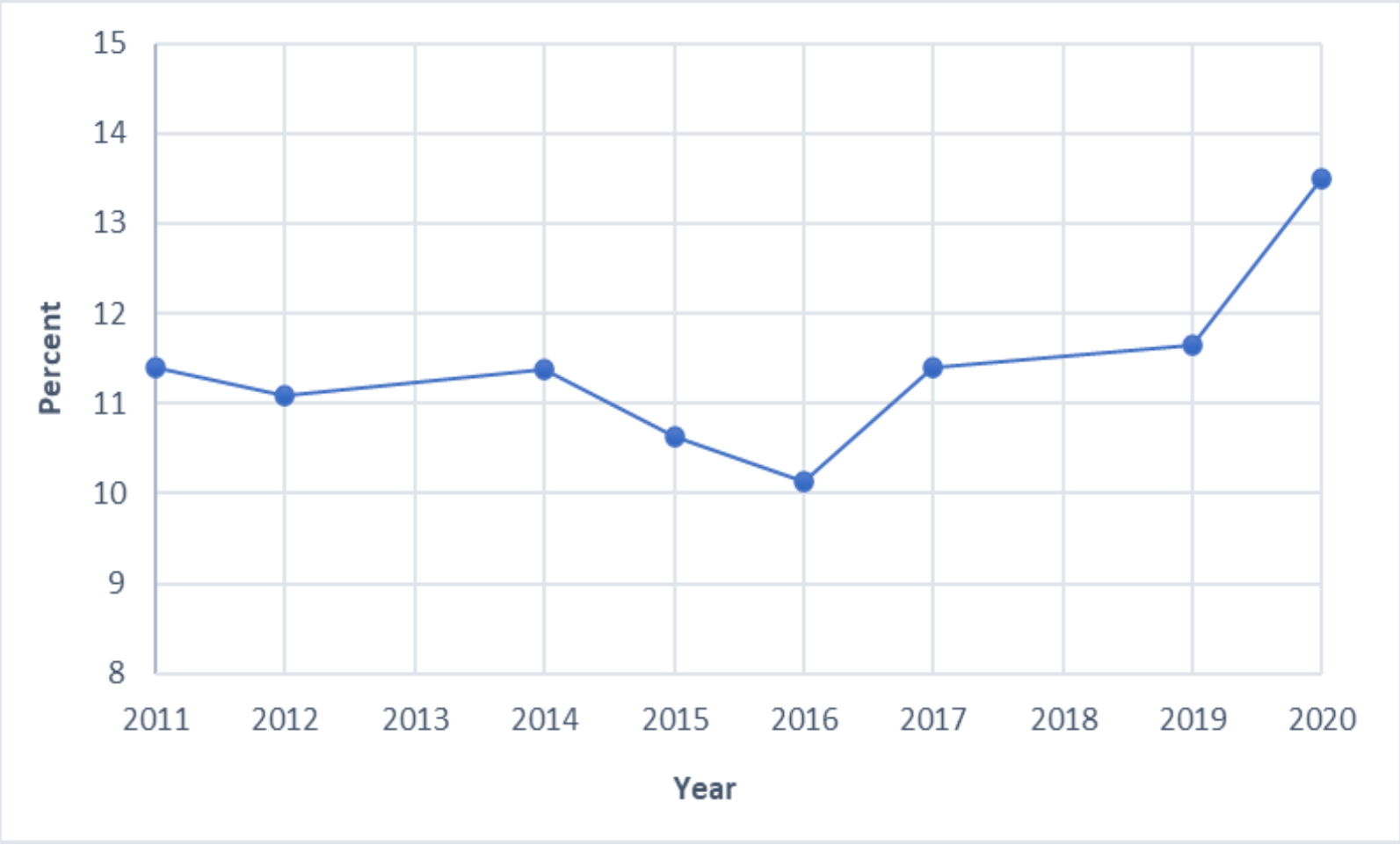
SINGLE FAMILY RESIDENTIAL



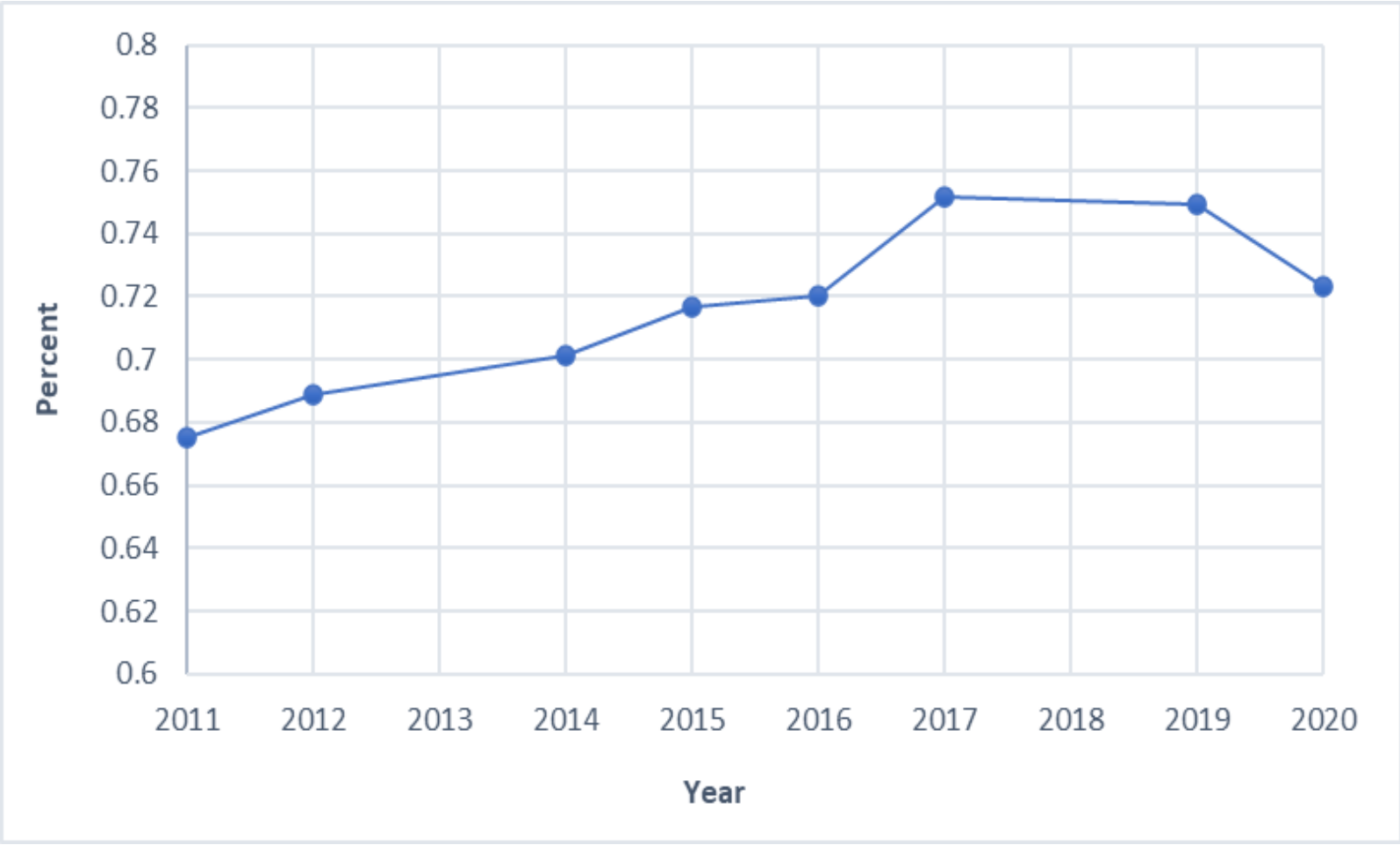
MULTI FAMILY RESIDENTIAL



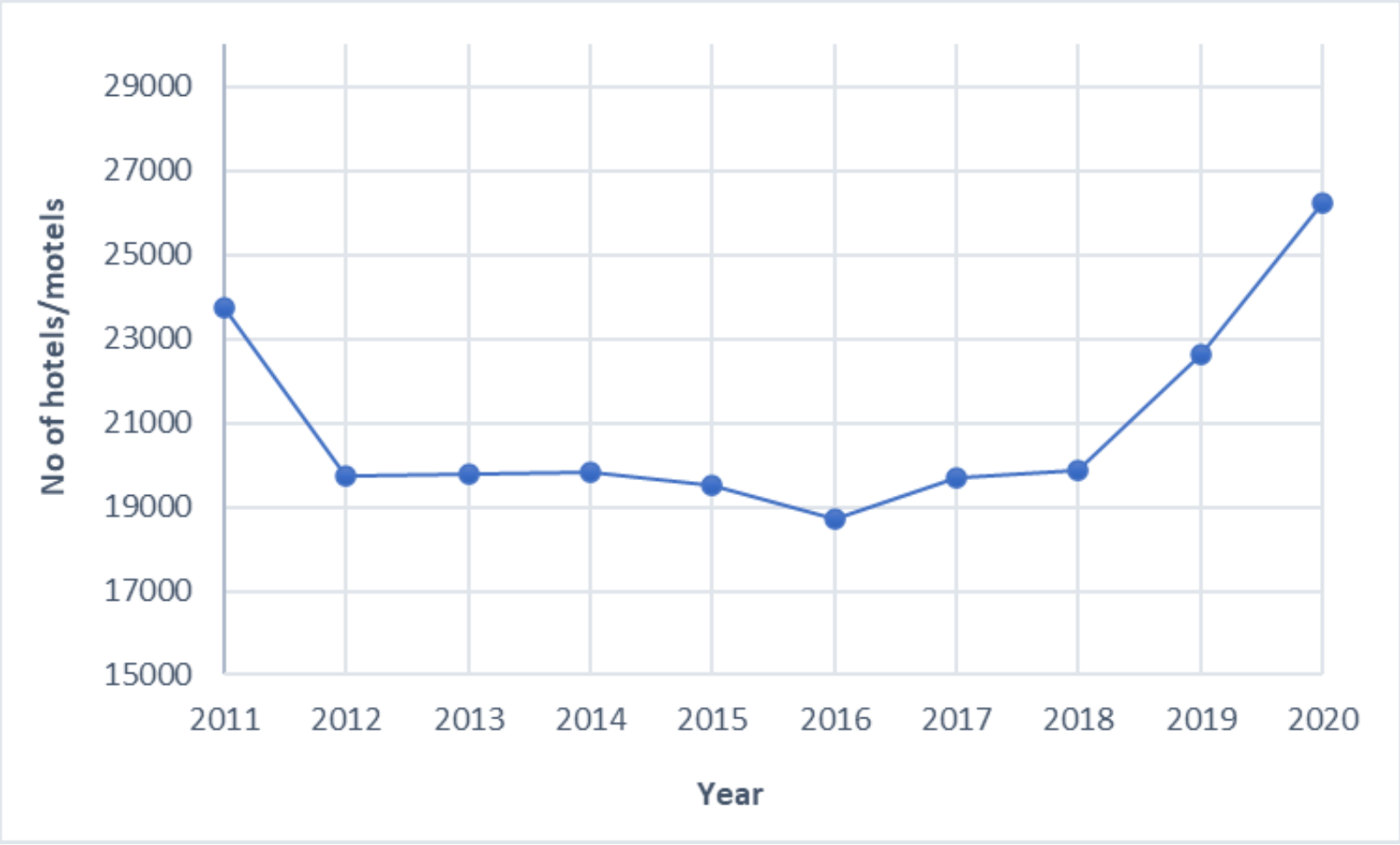
PUBLIC LU PERCENT



LU MIX VARIABLE

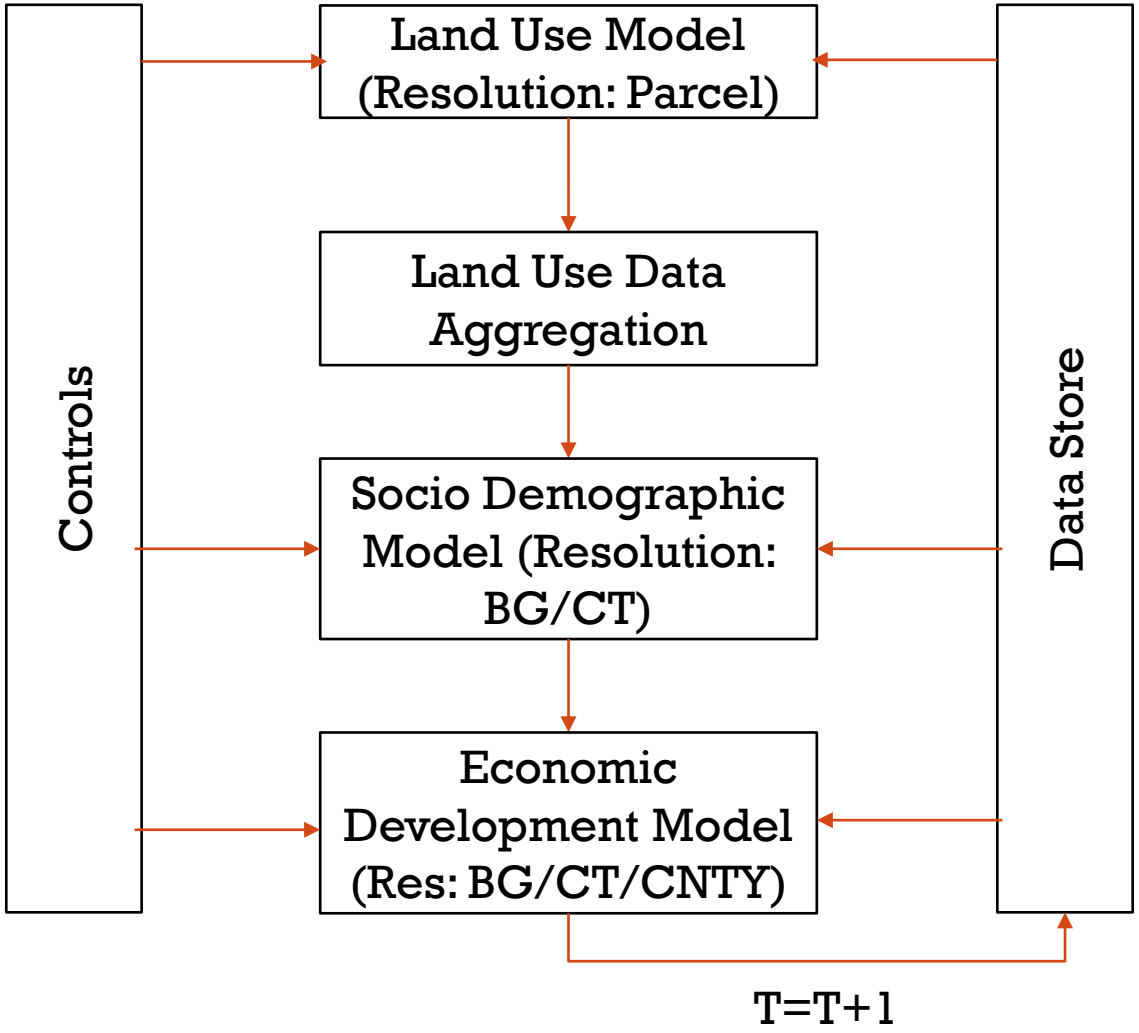


NUMBER OF HOTELS/MOTELS

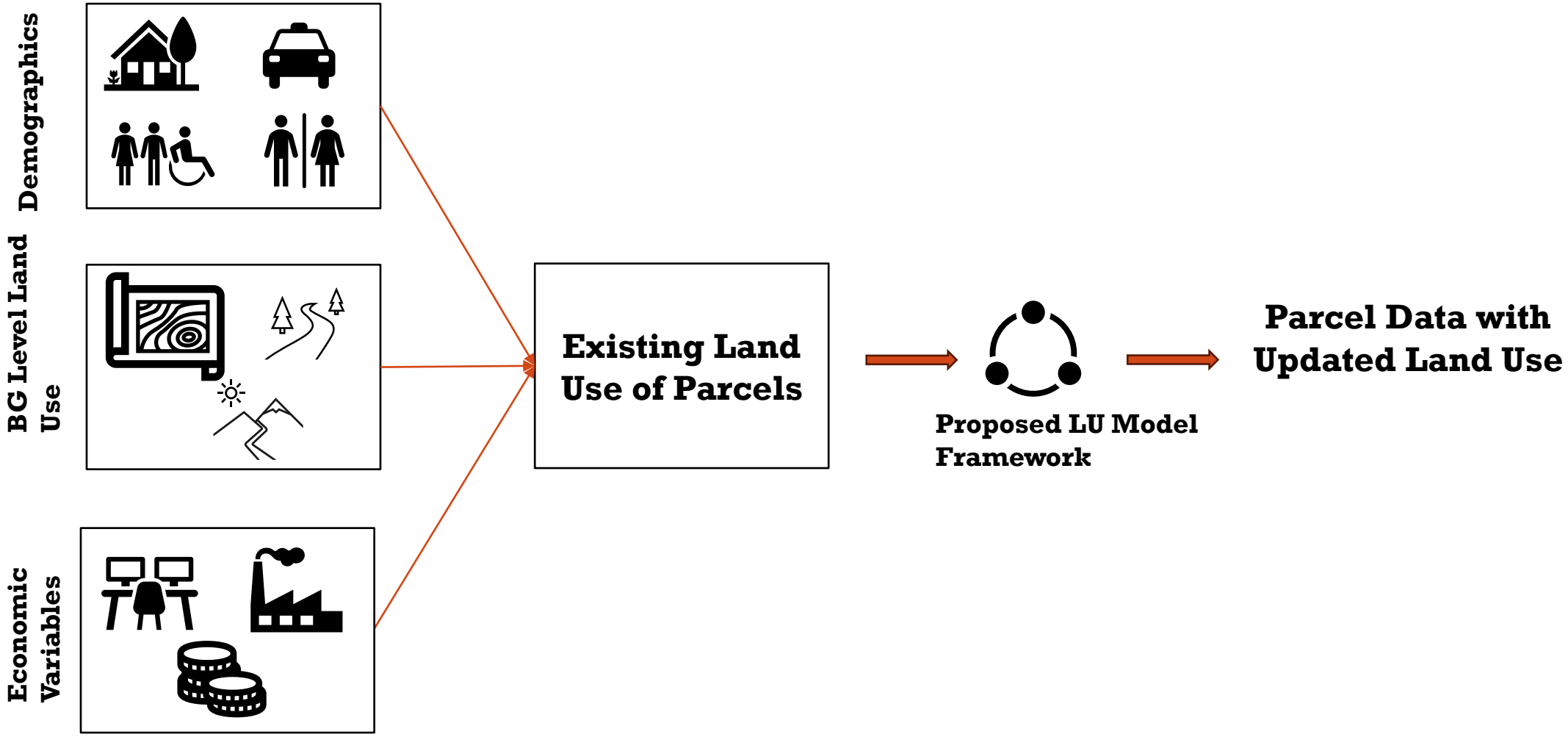


CONCEPTUAL FRAMEWORK FOR LAND USE EVOLUTION

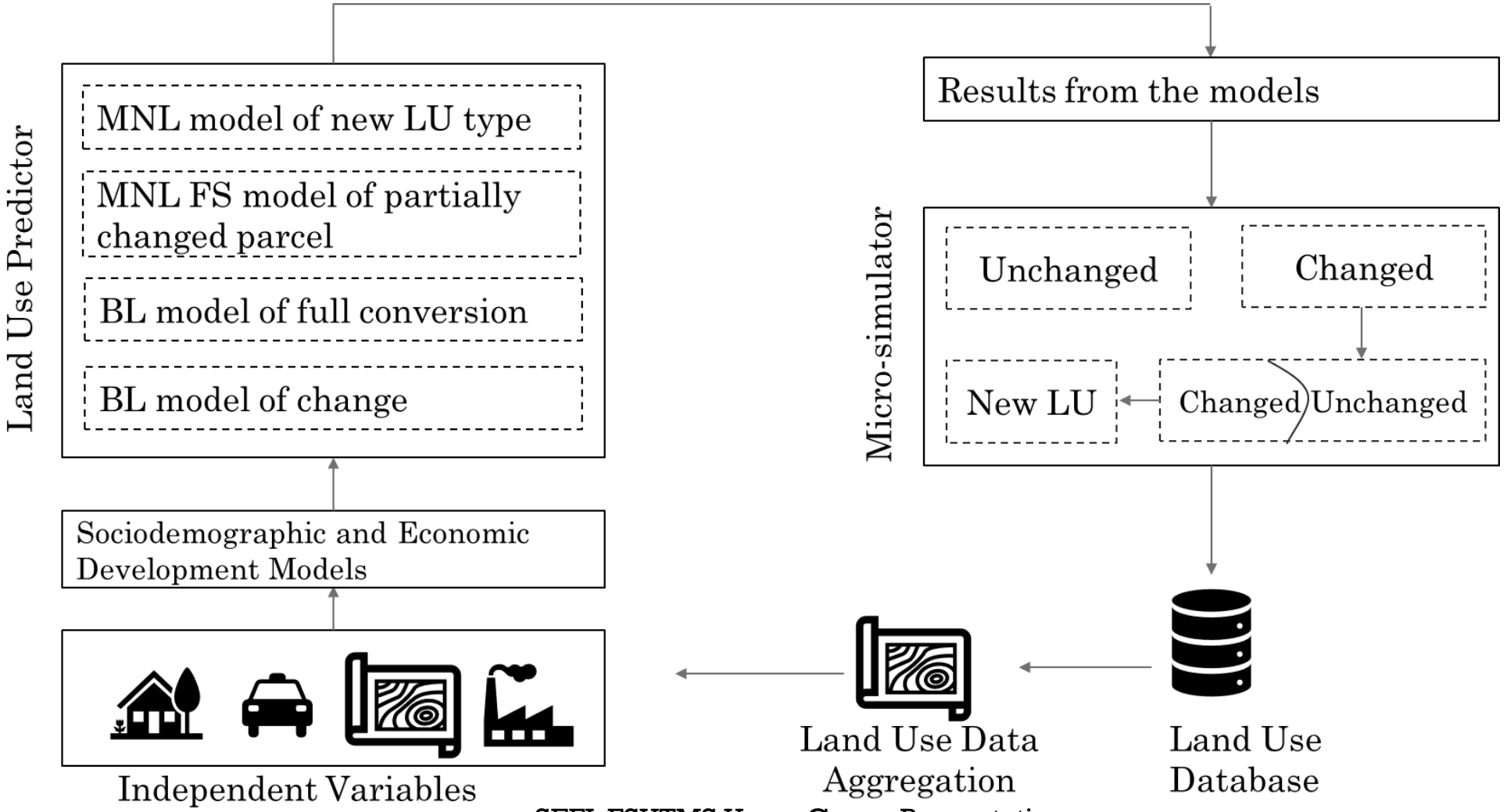
MODEL FRAMEWORK



LAND USE MODEL



LAND USE MODEL FRAMEWORK



SOCIO-DEMOGRAPHIC VARIABLES

Socio-demographics	Dependent Variable	Resolution	Forecasting Method	Independent Variables
Population	Population Change	Block Group	Linear Regression	Demographics, economic factors at year t and land use change between t and t-1
No of HHs	No of HHs	Census Tract	Conversion Factor	Population at year t
Vehicle ownership	Fraction of Ownership Level	Census Tract	MNL Fractional Split	Demographic and economic factors at year t-1
Race Distribution	Population by Race	Block Group	MNL Fractional Split	Demographic and economic factors at year t-1

ECONOMIC DEVELOPMENT VARIABLES

Economic Development	Dependent Variable	Resolution	Method	Independent Variables
No of Jobs	Jobs in thousand	County	Linear Regression	Sociodemographic and land use at year t-1
No of jobs by industry	Fraction of jobs	County	MNL based Fractional Split	Land use at year t-1
No of Businesses	Number of businesses	County	Conversion Factor	Number of jobs
Median Income	Median income in thousand	Census Tract	Linear Regression	Sociodemographic, land use and economic development at year t-1

MODEL ESTIMATION

SINGLE FAMILY RESIDENTIAL

CHANGE VS. NO CHANGE MODEL

- Model: Binary Logit (Base: No Change)

Variable	Estimate	t stat
Intercept	-3.300	-46.29
BG level Race Distribution (Base: % Other Race groups)		
% Hispanic	-0.015	-8.528
CT level vehicle ownership (Base: % HHs with vehicles)		
% Zero Vehicle HHs	0.021	4.852
Job density	0.205	3.634
Ln(Area in Acre)	-0.435	-15.306
BG level Land Use (% by area) (Base: Other LUs)		
% Single Family Residential	-0.02	-14.962
% Multi-Family Residential	0.012	2.837
% Flood Zone A	0.007	2.817

FULL VS. PARTIAL CONVERSION

- Model: Binary Logit (Base: Partial Conversion)

Variable	Estimate	t statistic
Intercept	-0.654	-5.091
Pop density (per acre)	-0.076	-5.784
Block Group Level Race Distribution (Base: % White, Black American and Other Race)		
% Hispanic	0.015	7.760
% Asian	-0.066	-5.766
CT level vehicle ownership (Base: % Households with vehicles)		
% Zero Vehicle HHs	0.026	5.891
Job density (per acre)	-0.695	-9.110
Block Group Level Land Use (% by area) (Base: Other Land Use Categories)		
Single Family Residential	0.007	4.293
Mixed Use	0.156	5.593
Commercial	-0.014	-3.327
Vacant Land Use	-0.004	-2.196
Land Use Mix/ Land Use Diversity	-2.006	-9.742

PROPORTION OF AREA CHANGED

- Model: MNL based Fractional Split (Base: % No Change)

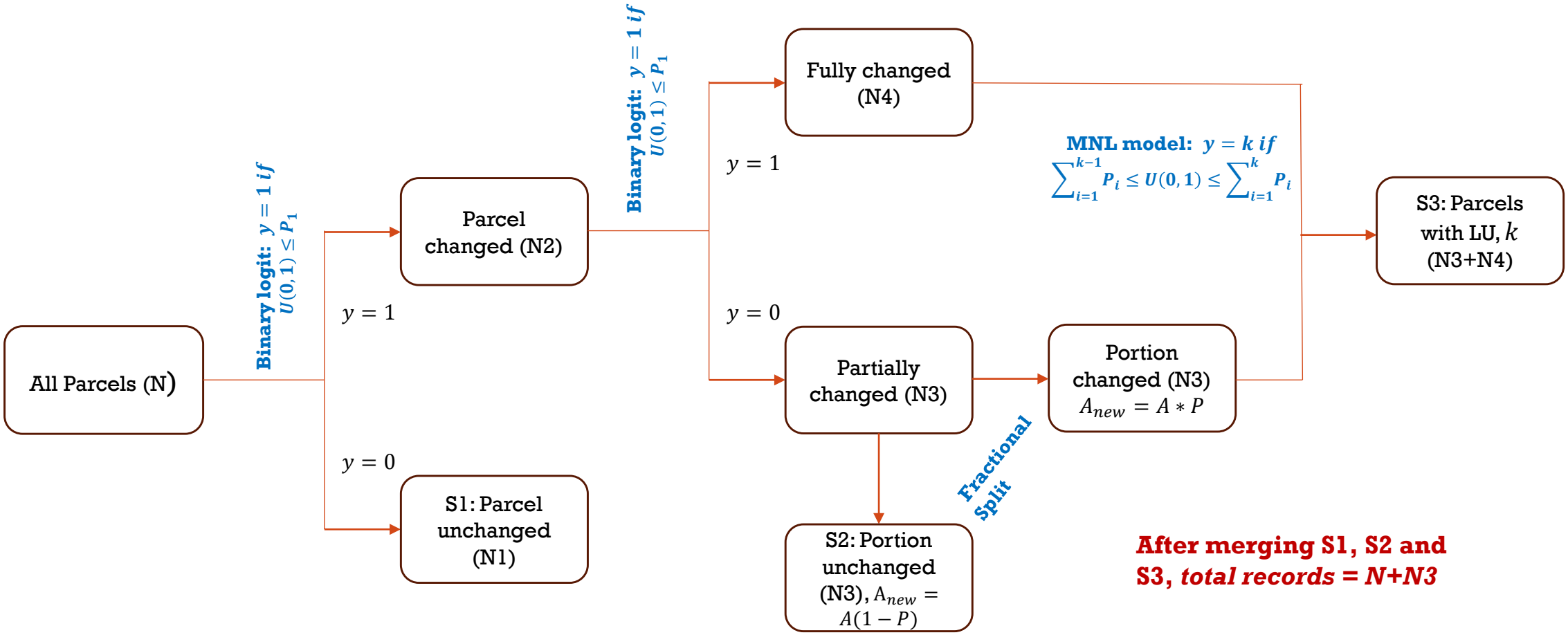
Variable	Estimate	t statistic
Intercept	-1.248	-27.363
Population density	-0.014	-2.484
Block Group Level Race Distribution (Base: % White and Hispanic)		
% Black American	-0.005	-5.059
% Asian	-0.008	-1.945
% Other Race	0.015	2.427
Job density	-0.371	-9.129
Block Group Level Land Use (% by area) (Base: Other Land Use Categories)		
% Single Family Residential	-0.004	-4.397
% Mixed Use	0.054	3.521
% Commercial	-0.013	-7.080
% Vacant Land Use	-0.007	-6.258

NEW LAND USE TYPE

- Model: Multinomial Logit Model (Base: Other Residential)

Variables	Vacant Residential		Others		MF Residential		Recreational		Public		Agricultural		Low Share Categories	
	Est.	t stat	Est.	t stat	Est.	t stat	Est.	t stat	Est.	t stat	Est.	t stat	Est.	t stat
Intercept	1.218	5.272	-0.299	-1.111	-2.824	-7.494	-1.173	-3.494	-1.982	-3.770	3.818	12.238	-1.137	-5.397
Pop density (per acre)	-0.100	-9.138	-0.067	-4.317	--	--	--	--	-0.064	-2.683	-0.978	-11.294	-0.100	-8.492
Block Group Level Race Distribution (Base: % White)														
% Hispanic	0.003	1.737	0.006	3.249	0.011	5.724	--	--	0.014	3.414	-0.011	-3.772	--	--
% Black American	0.011	5.174	--	--	--	--	-0.029	-5.188	0.016	3.370	--	--	0.008	4.460
% Asian	-0.106	-10.839	-0.020	-2.083	-0.122	-7.501	-0.062	-3.797	--	--	-0.060	-3.092	-0.058	-5.913
% Other Race	-0.017	-1.746	-0.050	-3.401	--	--	--	--	-0.089	-3.613	--	--	-0.040	-3.160
Census Tract Level Vehicle Ownership (Base: % Households with vehicles)														
% Zero Vehicle HHs	0.088	15.168	--	--	0.127	17.016	0.051	3.796	0.069	5.924	--	--	0.074	11.217
Median Income	--	--	0.006	3.243	-0.010	-3.523	0.005	1.811	-0.011	-3.090	-0.013	-3.778	--	--
Job density (per acre)	-0.653	-10.394	-0.634	-7.640	--	--	-1.519	-11.779	-1.468	-10.488	--	--	--	--
Block Group Level Land Use (% by area) (Base: Other Land Use Categories)														
% Single Family	0.025	14.453	0.010	4.408	0.041	15.511	0.012	4.035	0.030	8.972	0.014	3.073	0.030	13.792
% Vacant Land Use	0.021	11.440	-0.012	-4.222	--	--	-0.036	-6.208	-0.027	-4.510	-0.013	-3.450	--	--
Land Use Mix	-1.738	-8.024	0.865	3.159	0.823	2.104	2.474	6.120	1.814	4.281	-2.980	-7.814	1.217	4.172

PREDICTION FRAMEWORK



After merging S1, S2 and S3, *total records = N+N3*

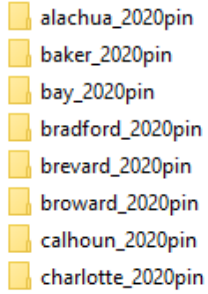
VARIABLE FORECASTS

VARIABLE FORECASTS

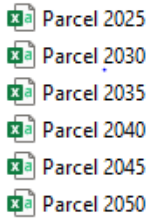
- The research team has completed future data generation using the proposed framework
- Future forecasts are provided by two data formats: .CSV and shapefile
- The data are submitted through 3 different folders:
  - 🗂️ GIS Layers
  - 🗂️ Parcel Files
  - 🗂️ Aggregated Files
- GIS layers and parcel files contain parcel level land use forecasts from 2025 to 2050
- Aggregated data folder consists of block group, census tract and county level sociodemographic, land use and economic development variable forecasts

VARIABLE FORECASTS

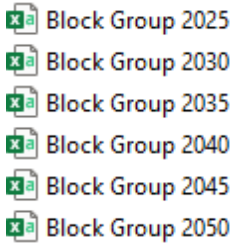
- GIS Layer folder consist of 402 county shape files (67 county files per year)



- Parcel folder consists 6 data files for the entire State (1 per year)



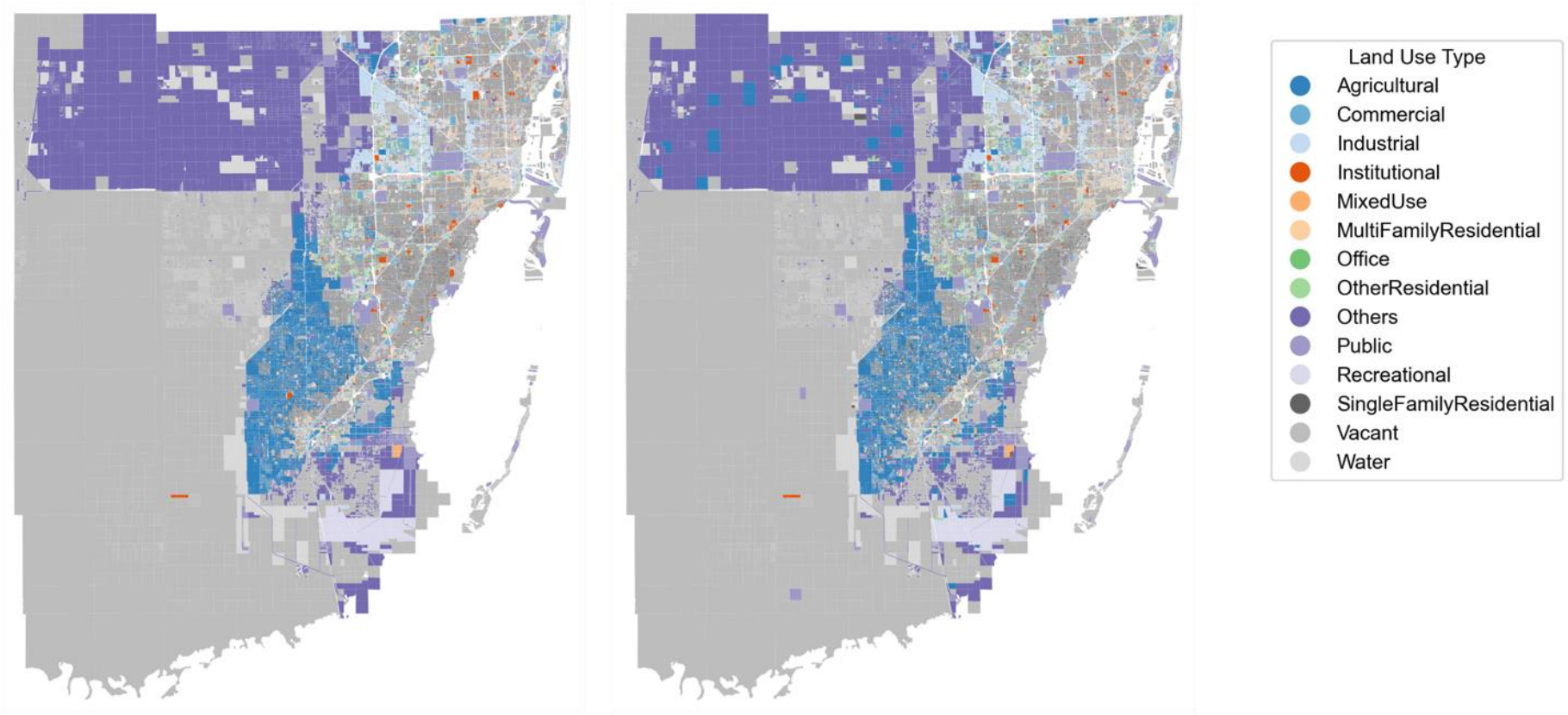
- Aggregate folder consists of 18 files for the entire State (6 files per resolution)



PARCEL DATA SAMPLE

	A	B	C	D	E	F	G	H
1	Par_uniq	PARCELNC	x	y	Landuse	BG.ID	Parcel_Area	Rank
2	1.12E+11	07702-000	-82.2898	29.80339	Agricultur	1.2E+11	1512003.2	1
3	1.12E+11	03206-000	-82.4824	29.79493	Others	1.2E+11	1070755.7	1
4	1.12E+11	03956-010	-82.4731	29.78104	Industrial	1.2E+11	255474.0	1
5	1.12E+11	03956-010	-82.4738	29.77931	Industrial	1.2E+11	358128.7	1
6	1.12E+11	05608-001	-82.4535	29.84439	VResident	1.2E+11	31477.4	1
7	1.12E+11	16979-000	-82.1648	29.80905	Others	1.2E+11	87119.0	1
8	1.12E+11	03956-010	-82.474	29.78083	VCommer	1.2E+11	44032.1	1
9	1.12E+11	17125-000	-82.1805	29.79086	VResident	1.2E+11	43904.3	1
10	1.12E+11	17125-001	-82.1811	29.79048	SingleFam	1.2E+11	165158.3	1
11	1.12E+11	05900-226	-82.417	29.75963	OtherResi	1.2E+11	13348.1	1
12	1.12E+11	05900-221	-82.4177	29.75855	OtherResi	1.2E+11	24975.1	1
13	1.12E+11	16972-029	-82.1738	29.81743	MultiFami	1.2E+11	143551.4	1
14	1.12E+11	05899-001	-82.4144	29.7671	VCommer	1.2E+11	108754.8	1
15	1.12E+11	17549-005	-82.2378	29.75059	SingleFam	1.2E+11	365818.9	1
16	1.12E+11	16979-001	-82.1655	29.80623	Agricultur	1.2E+11	386318.9	1
17	1.12E+11	05506-000	-82.4006	29.84741	Agricultur	1.2E+11	220222.0	1
18	1.12E+11	01636-006	-82.5889	29.77286	Agricultur	1.2E+11	412940.4	1
19	1.12E+11	01636-000	-82.5874	29.77201	Agricultur	1.2E+11	377262.2	1
20	1.12E+11	05949-005	-82.4377	29.76882	Agricultur	1.2E+11	4750499.2	1

PARCEL DATA SAMPLE



Miami-Dade 2020

Miami-Dade 2025

Parcel Level Land Use Forecast for 2025

BLOCK GROUP DATA SAMPLE

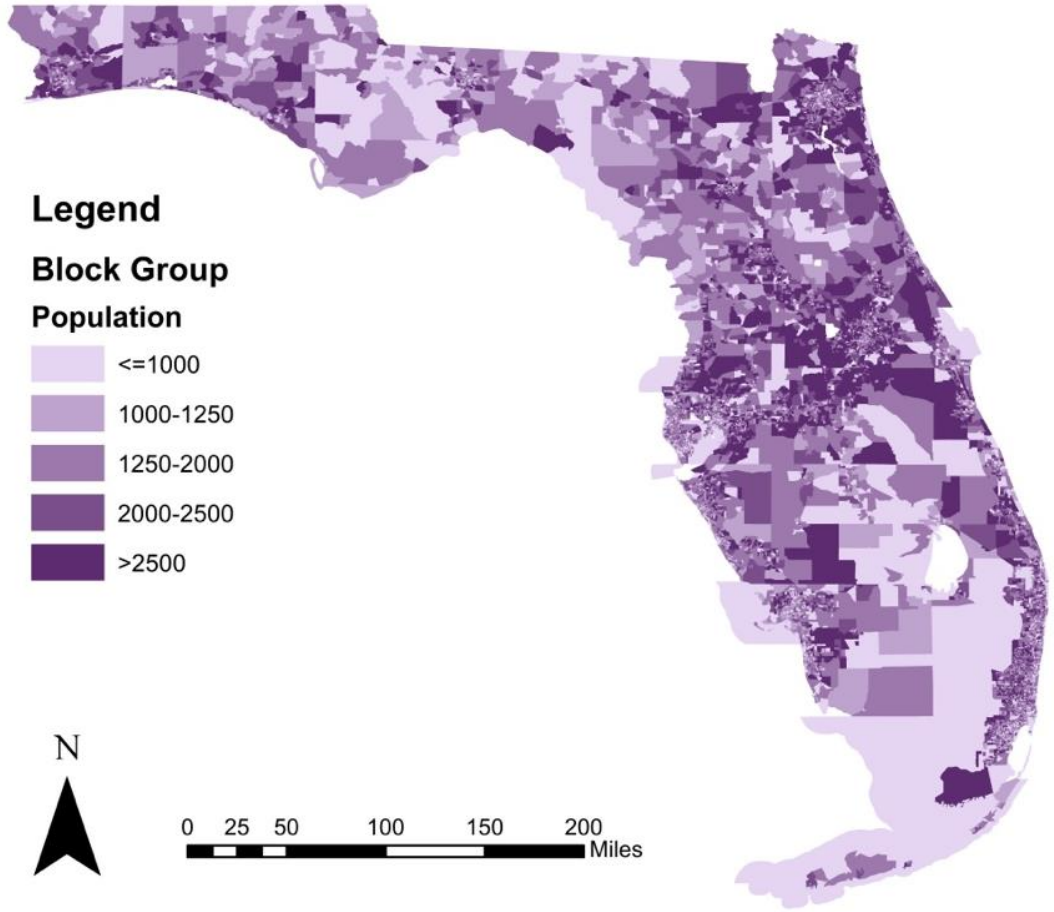
	A	B	C	D	E	F	G	H
1	BG.ID	BG.Popula	BG.Pop_d	BG.Hispar	BG.White	BG.Black_	BG.Asian	BG.Other_
2	120010002011	863.22	8.80	16.05	69.71	8.87	2.10	3.27
3	120010002012	1239.64	13.50	10.40	80.24	5.29	1.66	2.41
4	120010002013	1086.21	11.48	7.90	84.51	4.14	1.42	2.03
5	120010002014	1215.63	56.50	8.74	83.04	4.54	1.51	2.17
6	120010002021	1079.55	10.19	10.97	78.52	6.59	1.36	2.56
7	120010002022	1149.88	18.13	8.28	83.59	4.90	1.16	2.07
8	120010002023	2281.55	53.66	7.68	84.72	4.54	1.11	1.96
9	120010003011	2171.00	7.08	11.25	77.25	7.25	1.57	2.69
10	120010003012	2592.54	8.32	10.28	79.19	6.53	1.49	2.51
11	120010003021	581.17	1.36	11.87	74.77	8.84	1.61	2.91
12	120010003022	993.31	5.04	13.56	19.29	63.05	1.17	2.94
13	120010003023	1060.20	3.29	9.73	79.61	6.75	1.44	2.48
14	120010004001	1259.45	2.57	3.96	4.26	90.47	0.35	0.96
15	120010004002	791.25	3.74	10.05	12.53	74.31	0.88	2.23
16	120010004003	1621.98	6.39	9.75	80.04	6.30	1.48	2.43
17	120010004004	2981.65	5.58	5.09	5.59	87.66	0.45	1.21
18	120010005001	1522.65	4.45	8.86	82.06	5.29	1.51	2.28
19	120010005002	753.06	4.22	14.15	71.14	9.52	1.95	3.24
20	120010005003	926.37	5.04	7.55	84.61	4.48	1.35	2.01

BLOCK GROUP DATA SAMPLE

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	BG.ID	BG.Agri	BG.AllV	BG.Con	BG.Indu	BG.Inst	BG.Mix	BG.Mul	BG.Offi	BG.Oth	BG.Oth	BG.Pub	BG.Rec	BG.Sing	BG.Wat	BG.Lanc
2	120010002011	0.00	18.97	5.79	0.01	7.84	1.11	7.42	1.52	2.25	2.93	7.35	0.49	44.32	0.00	0.71
3	120010002012	0.00	12.51	6.54	0.69	0.85	0.52	14.44	11.35	2.15	0.43	12.62	0.35	37.55	0.00	0.73
4	120010002013	0.00	7.08	32.45	0.46	0.71	3.94	18.59	14.44	3.27	3.04	4.90	0.05	11.08	0.00	0.78
5	120010002014	0.00	7.40	11.13	0.00	19.26	3.70	49.37	2.60	3.01	2.54	0.00	0.00	0.99	0.00	0.71
6	120010002021	0.00	18.88	5.36	0.72	6.99	1.89	12.41	8.31	8.03	7.31	7.47	0.17	22.38	0.08	0.85
7	120010002022	0.00	10.30	0.22	0.00	32.99	0.00	39.13	3.48	6.07	0.33	0.53	0.17	6.79	0.00	0.65
8	120010002023	0.12	13.42	0.00	0.00	25.98	0.00	23.00	0.00	17.95	0.00	0.85	0.00	18.67	0.00	0.84
9	120010003011	0.00	9.22	14.72	3.11	1.57	0.43	21.66	7.86	4.85	0.17	10.11	0.57	25.71	0.01	0.78
10	120010003012	0.02	8.42	18.34	4.01	3.58	1.68	8.17	12.15	3.26	1.78	1.53	0.37	36.66	0.05	0.73
11	120010003021	0.00	11.13	22.14	30.34	3.14	0.12	1.77	1.05	1.37	0.73	13.08	0.11	15.02	0.00	0.74
12	120010003022	0.00	11.51	17.06	7.39	1.64	2.56	13.21	5.62	5.39	0.11	0.51	0.41	34.58	0.00	0.77
13	120010003023	0.03	11.11	21.39	0.00	5.52	0.00	6.59	6.42	2.98	0.11	0.48	0.34	45.02	0.00	0.67
14	120010004001	0.00	50.96	4.85	20.48	2.78	0.00	3.64	1.07	2.47	0.80	1.83	0.00	11.12	0.00	0.66
15	120010004002	0.15	5.18	1.37	2.58	2.97	0.83	2.00	0.19	0.63	0.59	20.61	0.07	62.82	0.02	0.47
16	120010004003	1.87	2.84	13.62	0.30	11.75	0.02	2.46	8.08	1.39	0.12	15.20	0.33	42.02	0.00	0.68
17	120010004004	15.48	7.91	22.93	0.22	4.16	0.00	3.73	0.32	1.03	2.10	8.44	0.15	33.53	0.00	0.74
18	120010005001	0.14	11.04	14.03	5.77	5.26	1.46	11.90	11.72	5.32	1.27	18.63	0.57	12.88	0.00	0.87
19	120010005002	0.00	0.68	10.38	1.54	4.33	0.20	3.46	2.07	0.23	0.24	27.33	0.50	49.05	0.00	0.58
20	120010005003	0.00	5.04	0.60	0.00	2.87	0.00	1.83	0.00	0.86	1.11	16.34	0.00	71.18	0.16	0.45

Land Use Variable Forecast for 2025

BLOCK GROUP DATA SAMPLE



Block Group Population Forecast for 2025

CENSUS TRACT DATA SAMPLE

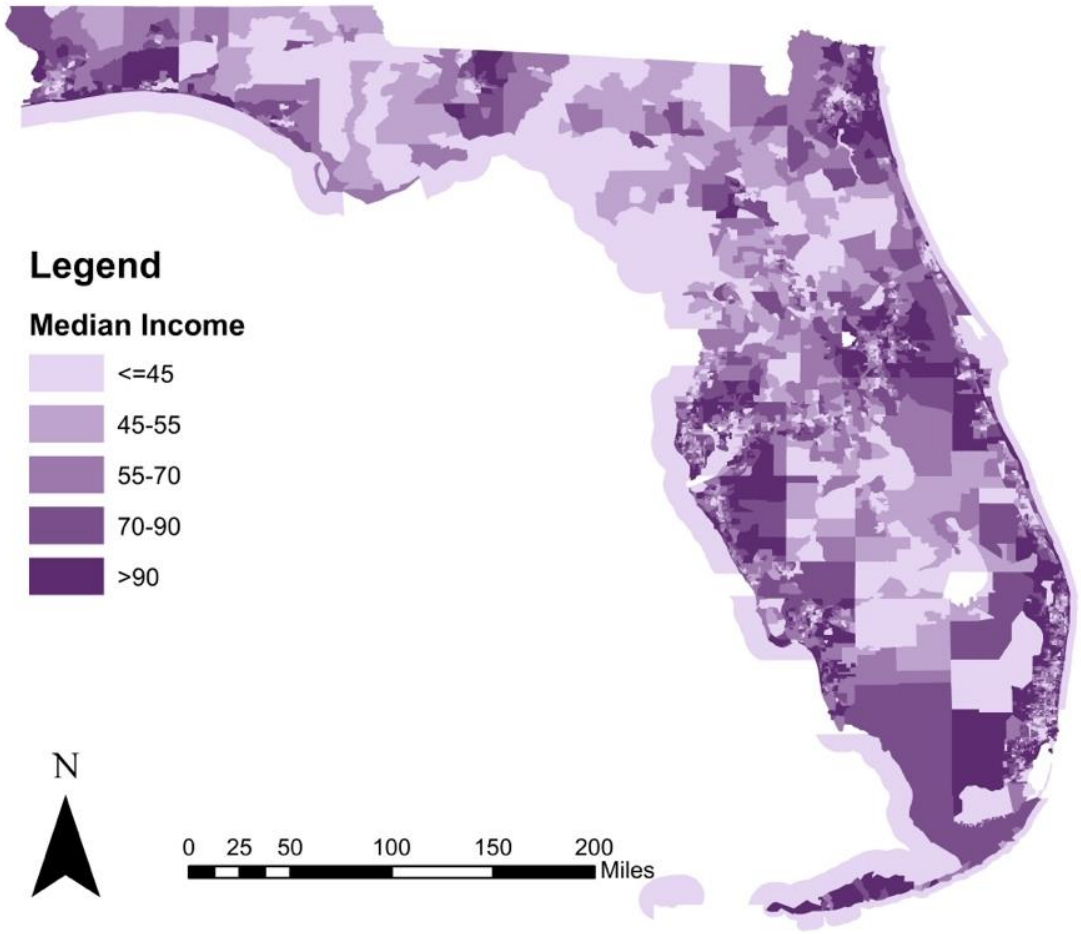
	A	B	C	D	E	F	G	H	I
1	CT.ID	CT.HH	CT.HH_der	CT.No_veh	CT.Veh1	CT.Veh2	CT.Veh3pl	CT.Income	CT.INC2
2	12001000201	1643.54	5.37	7.62	47.52	35.05	9.81	52127.49	52.13
3	12001000202	1683.20	7.94	23.92	53.42	18.82	3.84	12472.03	12.47
4	12001000301	1777.44	2.88	12.95	52.95	27.71	6.39	38908.46	38.91
5	12001000302	983.09	1.04	10.11	49.23	31.78	8.88	39548.60	39.55
6	12001000400	2482.96	1.67	10.66	51.29	30.52	7.53	44441.99	44.44
7	12001000500	2045.14	2.11	8.56	49.79	33.25	8.40	53343.22	53.34
8	12001000600	2238.24	1.18	18.67	54.58	22.22	4.54	26934.70	26.93
9	12001000700	2875.51	0.51	6.13	40.81	38.15	14.91	40948.73	40.95
10	12001000806	1190.81	5.07	19.79	54.53	21.37	4.31	24050.37	24.05
11	12001000808	1393.31	2.00	8.02	45.04	35.11	11.83	38565.84	38.57
12	12001001000	2851.70	2.04	4.47	35.43	40.78	19.31	41476.07	41.48
13	12001001100	2724.21	1.41	2.29	35.46	46.83	15.43	93067.41	93.07
14	12001001202	3386.41	2.33	2.73	34.32	45.16	17.79	73842.37	73.84
15	12001001400	2014.51	0.37	2.82	30.11	43.72	23.35	51738.17	51.74
16	12001001514	768.84	1.91	14.17	52.30	26.93	6.60	30847.40	30.85
17	12001001515	2200.13	5.72	19.18	53.97	22.12	4.72	22774.04	22.77
18	12001001516	1003.86	7.74	17.01	53.05	24.27	5.67	23954.80	23.95
19	12001001517	2205.32	5.91	12.55	50.52	29.02	7.91	30462.58	30.46
20	12001001522	2783.95	2.52	16.39	53.53	24.54	5.53	28153.01	28.15

CENSUS TRACT DATA SAMPLE

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	CT.ID	CT.Agri	CT.AllV	CT.Com	CT.Indu	CT.Insti	CT.Mixe	CT.Mult	CT.Offi	CT.Othe	CT.Othe	CT.Pub	CT.Recr	CT.Sing	CT.Wat	CT.Land
2	12001000201	0.00	12.54	14.63	0.35	4.34	1.99	15.93	8.54	2.59	2.19	7.66	0.28	28.96	0.00	0.82
3	12001000202	0.02	15.22	2.75	0.36	18.58	0.94	22.53	5.20	9.43	3.75	4.07	0.14	16.97	0.04	0.77
4	12001000301	0.01	8.82	16.54	3.56	2.58	1.06	14.86	10.02	4.05	0.98	5.79	0.47	31.23	0.03	0.76
5	12001000302	0.01	11.20	20.83	15.24	3.64	0.58	5.79	3.83	2.75	0.39	6.18	0.25	29.30	0.00	0.77
6	12001000400	5.89	20.81	12.34	7.23	4.83	0.12	3.24	1.87	1.51	1.12	9.15	0.12	31.77	0.00	0.75
7	12001000500	0.05	7.84	7.83	2.76	3.65	0.72	9.31	5.47	2.32	0.71	16.46	0.45	42.40	0.03	0.70
8	12001000600	7.10	13.93	4.55	1.42	4.23	0.25	2.01	0.12	1.11	7.35	42.39	0.22	15.28	0.04	0.69
9	12001000700	7.88	39.68	0.76	1.66	3.08	0.12	1.27	0.17	2.75	7.76	15.39	0.55	18.92	0.01	0.68
10	12001000806	0.21	5.11	7.38	19.77	22.76	0.00	24.82	3.04	6.76	3.63	0.68	0.02	5.83	0.00	0.79
11	12001000808	0.00	19.14	4.90	0.06	0.78	0.00	14.91	0.81	7.66	0.37	12.51	0.84	38.02	0.00	0.71
12	12001001000	0.01	17.83	1.71	0.00	2.66	0.13	3.84	1.18	1.10	0.52	6.29	0.05	64.69	0.00	0.48
13	12001001100	0.05	4.35	6.09	0.01	2.03	0.00	0.77	2.16	7.44	0.79	4.10	0.03	72.15	0.04	0.42
14	12001001202	0.06	8.94	1.76	0.52	5.66	0.00	6.81	0.87	11.21	3.24	3.70	3.44	53.78	0.02	0.62
15	12001001400	9.51	24.82	0.23	0.00	1.30	0.07	0.10	0.05	9.04	7.85	33.34	1.19	12.05	0.46	0.69
16	12001001514	0.00	3.92	8.44	1.88	27.62	0.00	22.14	2.35	8.55	0.04	23.41	0.08	1.55	0.00	0.76
17	12001001515	0.00	14.25	6.49	0.00	0.59	0.01	49.04	0.52	25.84	0.04	0.52	0.01	2.69	0.00	0.56
18	12001001516	0.00	5.75	0.00	0.00	3.74	0.00	44.66	0.00	42.72	0.92	0.06	0.00	2.16	0.00	0.59
19	12001001517	4.98	7.73	3.27	0.05	1.77	0.00	51.35	9.51	11.64	0.72	1.41	1.51	6.05	0.00	0.68
20	12001001522	3.64	18.08	27.67	2.34	5.59	1.73	17.71	0.95	10.85	2.71	6.64	0.11	1.98	0.00	0.78

Land Use Variable Forecast for 2025

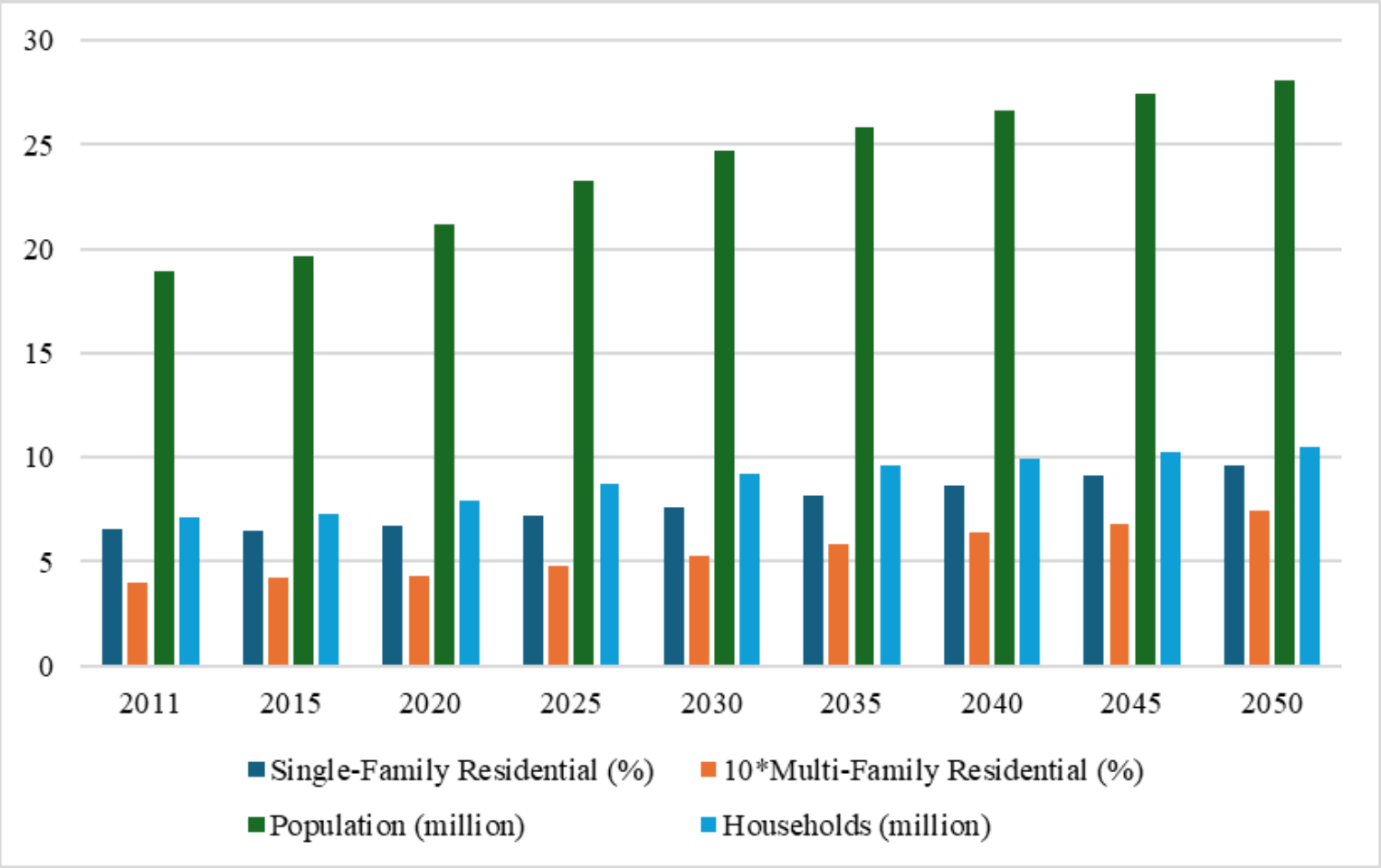
CENSUS TRACT DATA SAMPLE



Census Tract Median Income Forecast for 2025

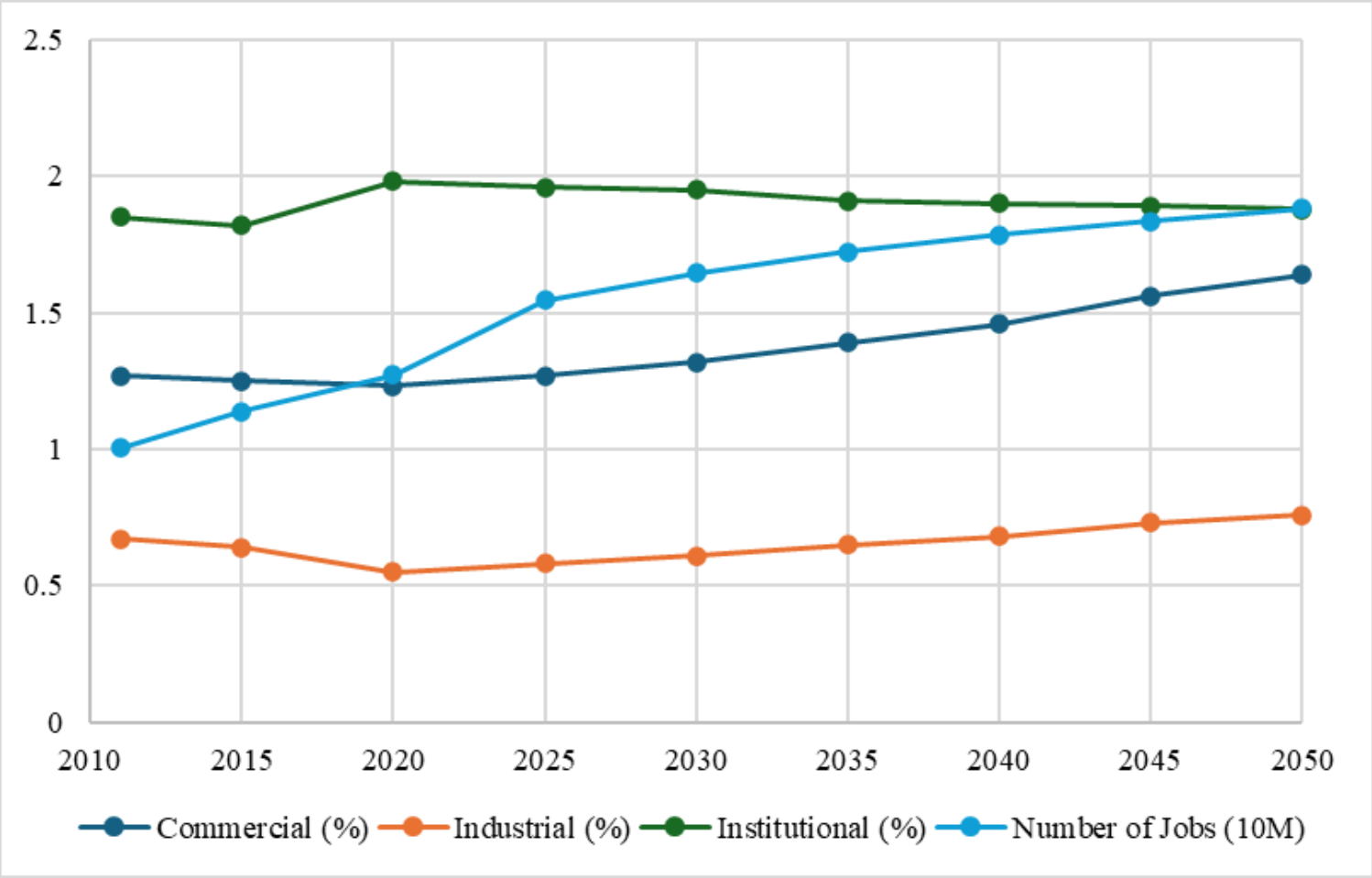
PREDICTION CONSISTENCY ANALYSIS

PREDICTION CONSISTENCY



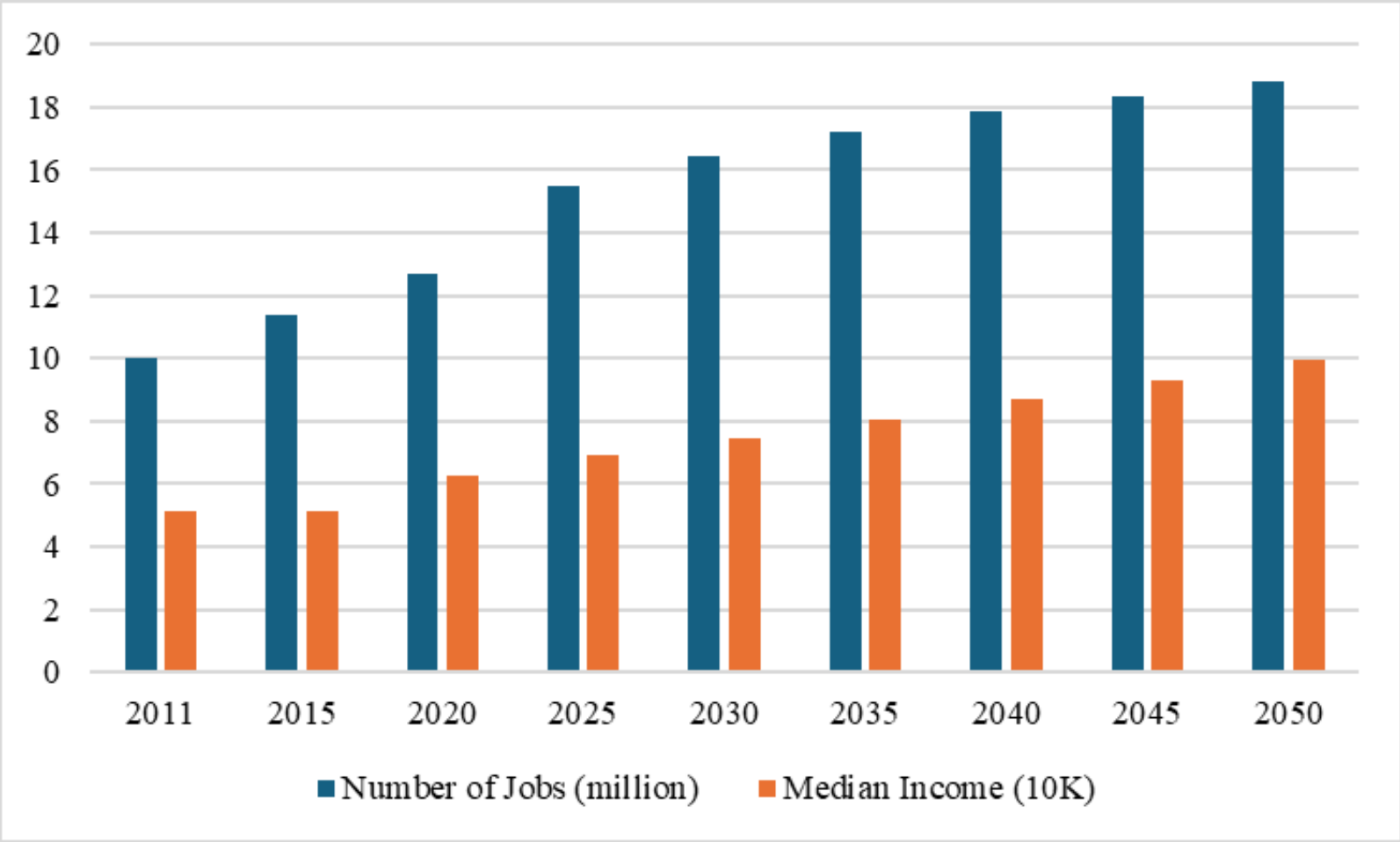
Residential Land Use, Population and Number of Households

PREDICTION CONSISTENCY



Commercial, Industrial and Institutional Land Uses and Number of Jobs

PREDICTION CONSISTENCY



Number of Jobs and Median Income

PREDICTION CONSISTENCY

Year	Population (million)	Number of Jobs (million)	Job per Capita
2011	18.90	10.04	0.53
2015	19.65	11.37	0.58
2020	21.22	12.72	0.60
2025	23.29	15.46	0.66
2030	24.70	16.44	0.67
2035	25.81	17.23	0.67
2040	26.68	17.85	0.67
2045	27.41	18.36	0.67
2050	28.07	18.81	0.67

Job per Capita by Year

PREDICTION CONSISTENCY

- We examine the consistency of the results from micro-simulator by running the predictions using different random number seeds
- For different draws of random numbers, land use change decisions change at the parcel level
- However, land use distribution at the aggregate levels e.g., block group, census tract and county should be consistent across the seeds

PREDICTION CONSISTENCY

Land Use	1st Run			2nd Run			3rd Run		
	Mean	Std. Dev.	25th,50th,75th Percentile	Mean	Std. Dev.	25th,50th,75th Percentile	Mean	Std. Dev.	25th,50th,75th Percentile
Agricultural	5.21	13.39	0.00,0.16,1.69	5.20	13.38	0.00,0.16,1.67	5.27	13.52	0.00,0.16,1.64
Commercial	7.74	11.88	0.73,3.13,9.52	7.69	11.84	0.72,3.12,9.36	7.69	11.90	0.71,3.08,9.44
Industrial	2.15	5.70	0.03,0.26,1.38	2.13	5.66	0.03,0.26,1.39	2.12	5.65	0.03,0.26,1.37
Institutional	2.00	5.30	0.13,0.53,1.92	1.98	5.23	0.13,0.52,1.91	2.01	5.29	0.13,0.53,1.95
Mixed Use	0.38	1.12	0.00,0.06,0.32	0.38	1.07	0.00,0.06,0.32	0.38	1.09	0.00,0.07,0.31
Multi-family Residential	5.88	11.38	0.48,1.62,5.77	5.91	11.38	0.49,1.64,5.85	5.90	11.42	0.48,1.61,5.75
Office	1.50	3.28	0.07,0.41,1.57	1.51	3.29	0.08,0.41,1.54	1.50	3.26	0.08,0.41,1.55
Other Residential	12.58	14.70	3.78,7.53,15.22	12.55	14.62	3.78,7.47,15.19	12.57	14.69	3.75,7.51,15.24
Others	4.73	8.25	0.52,1.56,5.34	4.80	8.36	0.53,1.55,5.44	4.74	8.19	0.52,1.57,5.34
Public	6.77	12.78	0.33,1.77,7.15	6.77	12.78	0.31,1.71,7.12	6.81	12.79	0.32,1.75,7.23
Recreational	2.05	5.19	0.18,0.58,1.64	2.06	5.30	0.18,0.57,1.66	2.09	5.28	0.17,0.58,1.72
Single-family Residential	34.20	25.45	12.55,29.78,52.07	34.25	25.51	12.57,29.89,52.11	34.20	25.46	12.64,29.72,52.18
Vacant Commercial	2.01	3.57	0.23,0.85,2.30	1.99	3.69	0.24,0.82,2.28	1.95	3.40	0.24,0.83,2.30
Vacant Industrial	0.39	1.59	0.00,0.01,0.14	0.40	1.61	0.00,0.01,0.15	0.39	1.61	0.00,0.01,0.15
Vacant Institutional	0.21	0.96	0.00,0.02,0.13	0.22	0.92	0.00,0.02,0.12	0.21	0.92	0.00,0.02,0.12
Vacant Public	4.24	9.90	0.23,0.94,3.45	4.23	9.83	0.23,0.94,3.52	4.22	9.90	0.23,0.93,3.46
Vacant Residential	6.77	10.87	1.15,3.37,7.94	6.78	10.91	1.16,3.38,7.90	6.79	11.02	1.15,3.37,7.80
Water	1.18	4.22	0.01,0.10,0.38	1.17	4.18	0.01,0.10,0.37	1.16	4.14	0.01,0.10,0.36

Block Group Level Consistency Check for 2050

PREDICTION CONSISTENCY

Land Use	1st Run			2nd Run			3rd Run		
	Mean	Std. Dev.	25th,50th,75th Percentile	Mean	Std. Dev.	25th,50th,75th Percentile	Mean	Std. Dev.	25th,50th,75th Percentile
Agricultural	6.37	13.99	0.07,0.44,3.53	6.31	13.92	0.07,0.43,3.47	6.37	13.99	0.07,0.44,3.53
Commercial	7.63	9.32	1.52,4.54,10.16	7.61	9.20	1.48,4.60,10.12	7.63	9.32	1.52,4.54,10.16
Industrial	2.37	5.18	0.13,0.56,1.95	2.39	5.24	0.13,0.55,2.00	2.37	5.18	0.13,0.56,1.95
Institutional	2.11	5.49	0.26,0.84,2.28	2.07	5.42	0.27,0.83,2.12	2.11	5.49	0.26,0.84,2.28
Mixed Use	0.37	0.88	0.03,0.13,0.40	0.36	0.79	0.03,0.13,0.40	0.37	0.88	0.03,0.13,0.40
Multi-family Residential	5.07	8.03	0.67,2.20,5.83	5.06	8.01	0.69,2.23,5.82	5.07	8.03	0.67,2.20,5.83
Office	1.51	2.69	0.20,0.66,1.75	1.52	2.77	0.19,0.66,1.75	1.51	2.69	0.20,0.66,1.75
Other Residential	11.38	11.17	4.33,7.83,14.74	11.41	11.20	4.32,7.94,14.36	11.38	11.17	4.33,7.83,14.74
Others	5.31	7.69	0.87,2.47,6.87	5.37	7.78	0.86,2.52,6.89	5.31	7.69	0.87,2.47,6.87
Public	8.11	13.21	1.12,3.56,9.22	8.05	13.17	1.04,3.51,9.01	8.11	13.21	1.12,3.56,9.22
Recreational	2.37	5.28	0.33,0.87,2.20	2.32	5.23	0.33,0.87,2.12	2.37	5.28	0.33,0.87,2.20
Single-family Residential	31.32	21.67	13.48,28.04,45.60	31.36	21.74	13.31,28.29,45.89	31.32	21.67	13.48,28.04,45.60
Vacant Commercial	1.94	2.66	0.43,1.13,2.44	1.94	2.80	0.44,1.12,2.41	1.94	2.66	0.43,1.13,2.44
Vacant Industrial	0.43	1.39	0.01,0.06,0.26	0.45	1.41	0.01,0.06,0.29	0.43	1.39	0.01,0.06,0.26
Vacant Institutional	0.22	0.97	0.01,0.05,0.17	0.23	0.94	0.01,0.05,0.17	0.22	0.97	0.01,0.05,0.17
Vacant Public	5.23	10.74	0.55,1.63,4.60	5.26	10.74	0.55,1.67,4.59	5.23	10.74	0.55,1.63,4.60
Vacant Residential	6.36	8.73	1.57,3.85,7.81	6.36	8.66	1.57,3.83,7.84	6.36	8.73	1.57,3.85,7.81
Water	1.24	3.82	0.05,0.16,0.59	1.27	3.88	0.05,0.17,0.59	1.24	3.82	0.05,0.16,0.59

Census Tract Level Consistency Check for 2050

PREDICTION CONSISTENCY

Land Use	1st Run			2nd Run			3rd Run		
	Mean	Std. Dev.	25th,50th,75th Percentile	Mean	Std. Dev.	25th,50th,75th Percentile	Mean	Std. Dev.	25th,50th,75th Percentile
Agricultural	30.73	19.48	14.32,27.05,45.36	30.49	19.19	14.29,27.43,43.89	30.77	19.18	15.07,28.19,44.55
Commercial	1.55	1.71	0.49,1.00,2.07	1.39	1.16	0.41,1.04,2.08	1.40	1.18	0.46,0.94,2.07
Industrial	0.65	0.66	0.27,0.42,0.84	0.65	0.67	0.25,0.42,0.82	0.67	0.66	0.25,0.52,0.75
Institutional	1.47	4.39	0.26,0.48,0.92	1.46	4.40	0.25,0.45,0.77	1.43	4.38	0.26,0.42,0.77
Mixed Use	0.10	0.09	0.04,0.08,0.14	0.09	0.07	0.05,0.07,0.11	0.10	0.07	0.04,0.09,0.14
Multi-family Residential	0.70	0.66	0.27,0.44,0.90	0.73	0.70	0.27,0.49,1.00	0.72	0.66	0.29,0.49,0.93
Office	0.26	0.24	0.10,0.20,0.33	0.26	0.19	0.11,0.21,0.36	0.26	0.21	0.10,0.21,0.36
Other Residential	3.82	2.48	2.24,3.37,4.89	3.70	1.90	2.46,3.49,4.76	3.80	2.32	2.48,3.40,4.60
Others	10.21	8.33	6.19,8.43,11.53	10.50	8.28	6.61,8.42,11.03	10.01	8.32	5.92,8.13,10.60
Public	12.54	14.96	3.89,7.44,16.43	12.41	14.93	4.04,7.49,16.07	12.43	14.82	4.05,7.27,16.31
Recreational	4.21	8.57	0.33,1.04,4.03	4.17	8.44	0.32,0.97,3.82	4.46	9.61	0.30,1.10,3.69
Single-family Residential	10.08	5.60	6.68,9.77,12.88	10.05	5.62	6.45,9.85,12.83	10.18	5.52	6.42,10.00,12.70
Vacant Commercial	0.79	0.37	0.48,0.81,1.01	0.87	0.54	0.58,0.80,1.02	0.86	0.95	0.44,0.80,0.98
Vacant Industrial	0.21	0.17	0.10,0.17,0.27	0.21	0.18	0.09,0.15,0.27	0.23	0.17	0.10,0.19,0.32
Vacant Institutional	0.11	0.14	0.05,0.07,0.12	0.11	0.13	0.04,0.08,0.12	0.11	0.13	0.04,0.08,0.13
Vacant Public	8.39	10.92	1.20,2.83,12.55	8.60	11.11	1.15,3.19,12.56	8.32	10.97	1.18,2.86,12.11
Vacant Residential	4.96	2.51	3.11,4.68,6.85	5.06	2.48	3.34,4.64,6.80	5.01	2.49	3.27,4.59,6.60
Water	1.06	3.48	0.10,0.18,0.71	1.10	3.66	0.08,0.19,0.71	1.08	3.67	0.08,0.21,0.71

County Level Consistency Check for 2050

FUTURE WORK

- The results are being vetted by FDOT and will be shared with all stakeholders once they are ready to be finalized
- The final report will contain a summary of the research project including:
  - Literature review
  - Stakeholder survey
  - Model framework
  - Base and future year data generation
  - Knowledge transfer activities

TAKEAWAYS

Objective: Build a standard sociodemographic, land use and economic indicator framework for Florida

Approach: A microsimulation framework synthesizing changes every year at the finest resolution allowed by data available

Implementation: Land use changes at the parcel level in open-source software, aggregate these changes to block group, tract as necessary and model sociodemographic and economic indicators for next year

Consistency: Checked the data from multiple directions, tested the models and their outputs, tested the synthesis process and finally output from different model runs evolving 2020-2050 were performed

Products: This is a sneak peek and data should be available for all of you to use in 2-3 months

ACKNOWLEDGEMENTS

- Team Members
  - Sudipta Tirtha
  - Lauren Hoover
  - Md Istiak Jahan
  - Dewan Parvez
  - Susmita Sarker
- Others
  - Sheldon Harrison
  - Krishnan Viswanathan
- FDOT personnel
  - Thomas Hill (program manager and main advocate)
  - Vladimir Majano
  - Terry Corkery

QUESTIONS

- For more details - https://people.cecs.ucf.edu/neluru/
- Email: naveen.eluru@ucf.edu