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Finding Relationships between Commodity Flow and Land Use

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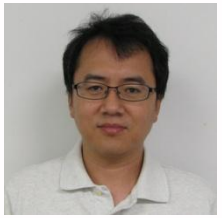

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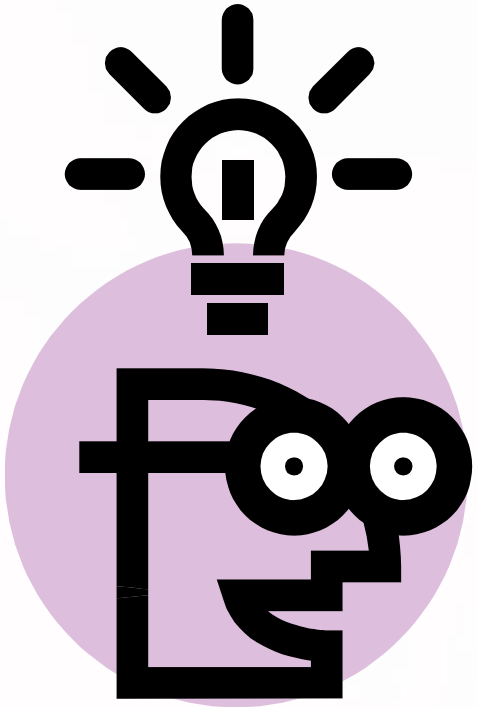
Presentation Outline

- Background
- Motivation
- Analysis Process
- Data Availability
- Land Use Types
- Commodity Classifications
- Analysis Results: GIS-based analysis, Correlation analysis, Multiple regression models
- Conclusion and Recommendations

Background

- Differences exist between passenger and freight transportation. But, often, a concept similar to passenger demand modeling methods have been used for freight demand modeling.
- Land use - one of the most important factors affecting the level of commodity flow.
- Lack of data has hindered finding relationships between commodity flow and land use.
- In the past decade, commodity flow related data have been collected by the federal government (in the USA), although they are still in aggregated at state-level, and now land use, economic, and employment data are becoming widely available via the Internet at no cost.

Motivation



Why not develop macro-level models that will give decent ball-park estimates of commodity flow using land-use types as independent variables now that necessary data are becoming available to users at no cost?

Developing multiple linear regression models is a starting proint.

Analysis Process

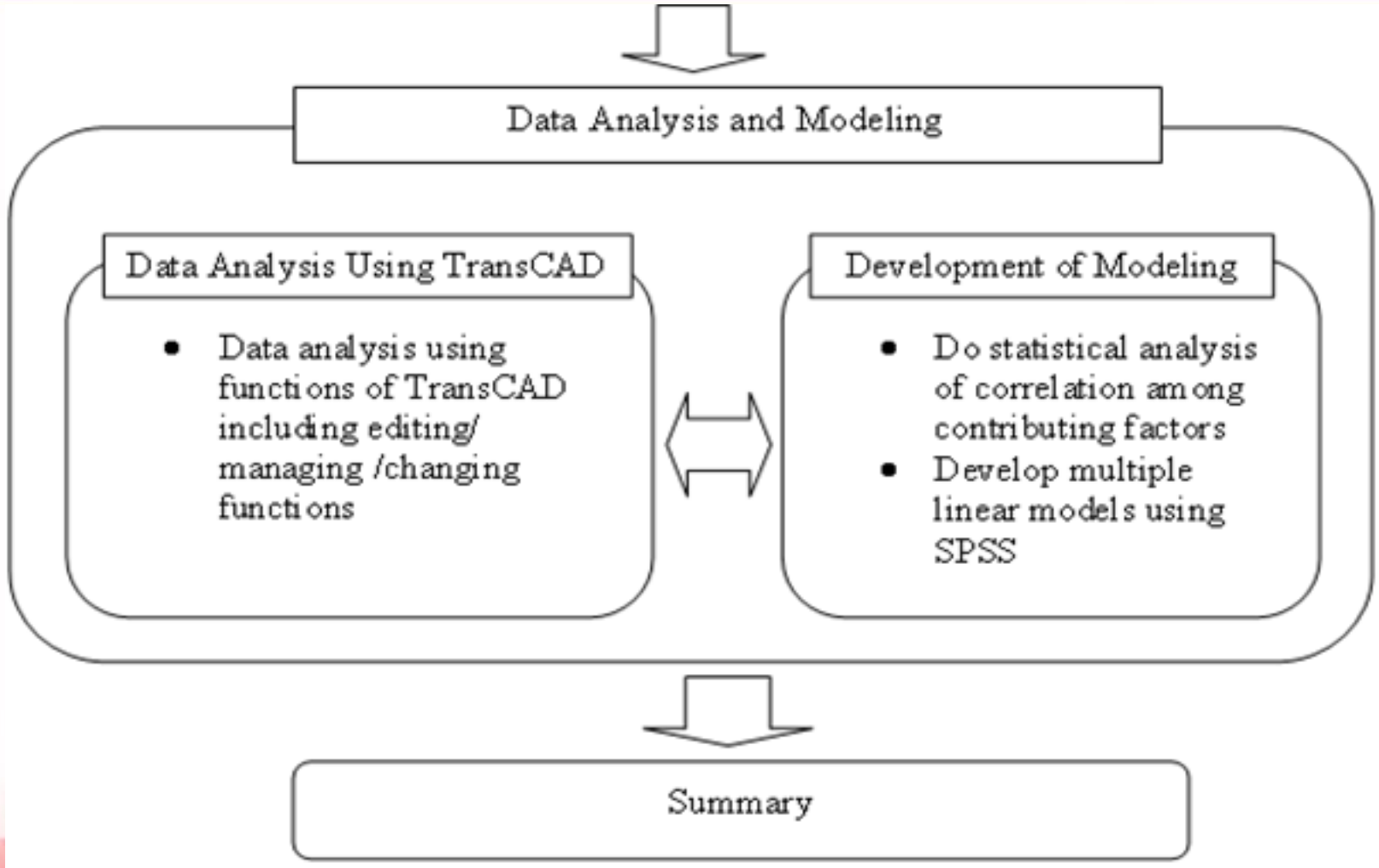
Data Collection

- Land use data: Industrial/commercial type by county
- Commodity freight data: Utah business pattern by county
- Economic and social data: Economic activity data and population
- Geographic data: Utah county map and highway network

Data Sorting and Reduction

- Using TransCAD and Microsoft Excel, data sorting and reduction
- Define traffic analysis zone (TAZ) as county
- Define highway network including truck highway routes
- Loading/changing format of all data for TransCAD

Analysis Process (cont.)



Data Availability

- Commodity Flow Survey (CFS) – 2002 and 2007 data available
- Freight Analysis Framework – 2002 and 2007 available
- Utah GIS Portal (Land use data)

Land Use Types Used for the Analysis

- IR = Irrigation area
- NI = Non-irrigation area
- RES = Residential area
- RIP = Riparian area
- URB = Urban area
- Water = Water area

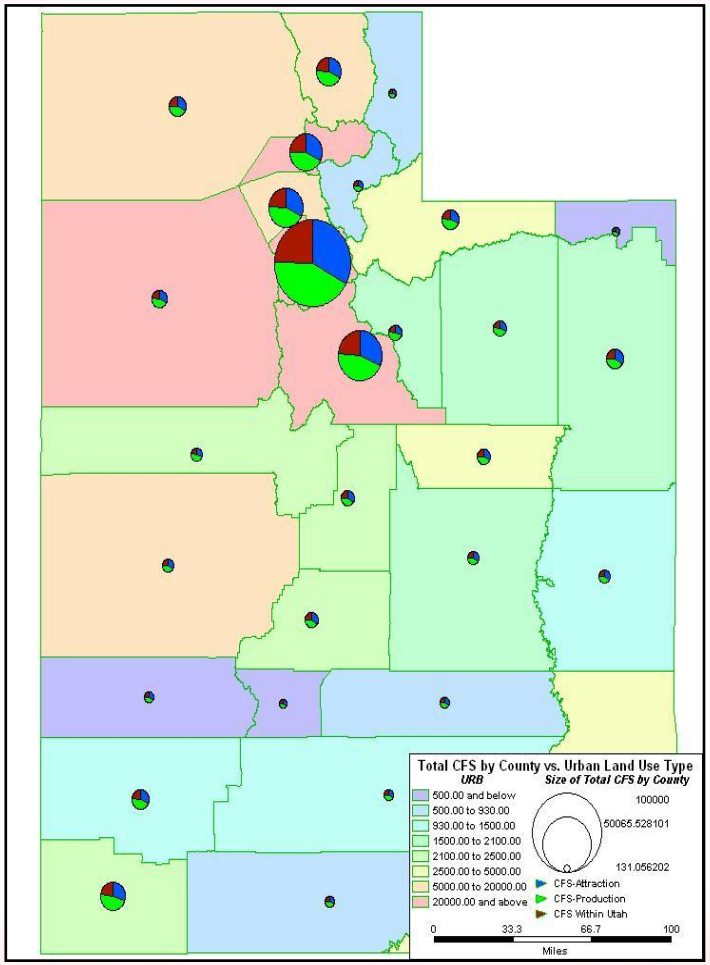
Commodity Classifications by SIC code

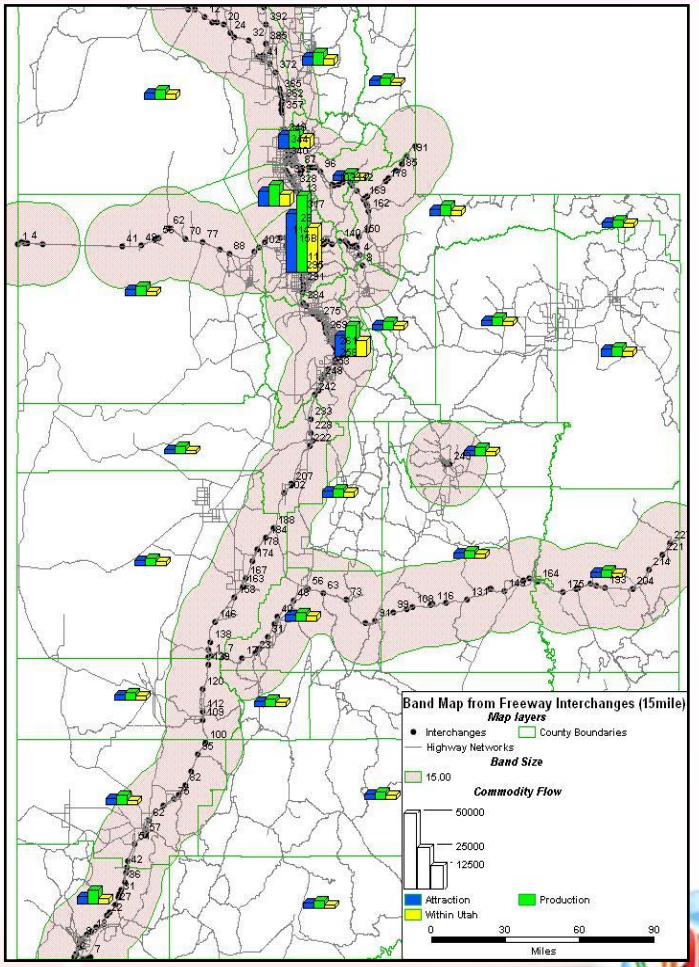
SIC Code	Description	Production CFS2P	Attraction CFS2A	Within CFS2I
	All Commodities (Code T was used)	CFS2PT	CFS2AT	CFS2IT
1	Live animals and live fish	CFS2P1	CFS2A1	CFS2I1
2	Cereal grains	CFS2P2	CFS2A2	CFS2I2
3	Other agricultural products	CFS2P3	CFS2A3	CFS2I3
4	Animal feed and products of animal origin, nec*	CFS2P4	CFS2A4	CFS2I4
5	Meat, fish, seafood, and their preparations	CFS2P5	CFS2A5	CFS2I5

39	Furniture, mattresses and mattress supports, lamps, lighting fittings	CFS2P39	CFS2A39	CFS2I39
40	Miscellaneous manufactured products	CFS2P40	CFS2A40	CFS2I40
41	Waste and scrap	CFS2P41	CFS2A41	CFS2I41
43	Mixed freight	CFS2P43	CFS2A43	CFS2I43
——	Commodity unknown	CFS2P99	CFS2A99	CFS2I99

SIC = Standard Industrial Classification

GIS Analysis of Data to Check Trends





Correlation Analysis

		CFS2PT	CFS2AT	CFS2IT
IR	Pearson Correlation	0.205	0.207	0.205
	Significance (2-tailed)	0.286	0.282	0.286
	N	29	29	29
NI	Pearson Correlation	0.498	0.501	0.498
	Significance (2-tailed)	0.006	0.006	0.006
	N	29	29	29
RES	Pearson Correlation	0.914	0.914	0.914
	Significance (2-tailed)	0.000	0.000	0.000
	N	29	29	29
RIP	Pearson Correlation	0.474	0.465	0.474
	Significance (2-tailed)	0.009	0.011	0.009
	N	29	29	29
URB	Pearson Correlation	0.860	0.857	0.860
	Significance (2-tailed)	0.000	0.000	0.000
	N	29	29	29
WATER	Pearson Correlation	-0.069	-0.059	-0.069
	Significance (2-tailed)	0.724	0.763	0.724
	N	29	29	29

Multiple Regression Models

$$\ln(CFS2P_i) = \text{Constant}_{\,i} + \sum_{j=1}^{6} a_{ij} \ln\left(LandUseType_j\right)$$

Where, *i* = Commodity flow classification SIC code
j = Land use type

$$\ln(CFS2A_i) = \text{Constant}_{\,i} + \sum_{j=1}^{6} a_{ij} \ln\left(LandUseType_j\right)$$

$$\ln(CFS2I_i) = \text{Constant}_{\,i} + \sum_{j=1}^{6} a_{ij} \ln\left(LandUseType_j\right)$$

P = Production, A = Attraction, I = Within a state

Regression
(CFSTA34)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.91157	0.83096	0.82470	0.70427
2	0.93070	0.86621	0.85592	0.63850
3	0.96178	0.92502	0.91602	0.48745

a Predictors: (Constant), RES_T
b Predictors: (Constant), RES_T, URB_T
c Predictors: (Constant), RES_T, URB_T, RIP_T

ANOVA(d)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	65.83277	1	65.83277	132.72876	0.00000
	Residual	13.39186	27	0.49599		
	Total	79.22462	28			
2	Regression	68.62503	2	34.31252	84.16604	0.00000
	Residual	10.59959	26	0.40768		
	Total	79.22462	28			
3	Regression	73.28448	3	24.42816	102.80955	0.00000
	Residual	5.94015	25	0.23761		
	Total	79.22462	28			

a Predictors: (Constant), RES_T
b Predictors: (Constant), RES_T, URB_T
c Predictors: (Constant), RES_T, URB_T, RIP_T
d Dependent Variable: CFSTA34

Coefficients(a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-10.60019	1.05320		-10.06475	0.00000
	RES_T	1.33348	0.11575	0.91157	11.52080	0.00000
2	(Constant)	-10.73237	0.95617		-11.22429	0.00000
	RES_T	1.05189	0.15029	0.71908	6.99892	0.00000
	URB_T	0.33056	0.12631	0.26888	2.61710	0.01458
3	(Constant)	-11.04590	0.73340		-15.06123	0.00000
	RES_T	1.23772	0.12217	0.84611	10.13097	0.00000
	URB_T	0.48014	0.10217	0.39056	4.69936	0.00008
	RIP_T	-0.30185	0.06816	-0.33450	-4.42831	0.00016

a Dependent Variable: CFSTA34

Stepwise Regression Steps

- With the natural log transformation
- Model selection done by Schwarz's BIC (Bayesian Information Criterion)

Sample Models for *Production*

Item Code	Constant	RES	URB	RIP	NI
CFSTPT	0.0038190325	3.3700	1.6170	0.7432	
CFSTP3	0.0000800101	2.9161			
CFSTP4	0.0000026377	4.3172			1.1156
CFSTP5	0.0000019376	4.3171			1.1156

SIC Code	Description
	All Commodities (Code T was used)
1	Live animals and live fish
2	Cereal grains
3	Other agricultural products
4	Animal feed and products of animal origin, nec*
5	Meat, fish, seafood, and their preparations

Commodity flow in 1000 tons,
Land use = acres

Sample Models for *Attraction*

Item Code	Constant	RES	URB	RIP	NI
CFSTAT	0.003727068	3.2212	1.6072	0.7616	
CFSTA2	0.000006597	4.3172			1.1156
CFSTA3	0.000024078	3.2927	1.6101	0.7544	
CFSTA4	0.000002943	4.3172			1.1156
CFSTA5	0.000021021	3.2025	1.6064	0.7636	

SIC Code	Description
	All Commodities (Code T was used)
1	Live animals and live fish
2	Cereal grains
3	Other agricultural products
4	Animal feed and products of animal origin, nec*
5	Meat, fish, seafood, and their preparations

Commodity flow in 1000 tons,
Land use = acres

Sample Models for *Within-State*

Item Code	Constant	RES	URB	RIP	NI
CFSTIT	0.00273395	3.2328	1.6076	0.7605	
CFSTI2	0.00000048	4.3171			1.1156
CFSTI3	0.00006267	2.876			
CFSTI4	0.00000118	4.3172			1.1156
CFSTI5	0.00000070	4.3171			1.1156

SIC Code	Description
	All Commodities (Code T was used)
1	Live animals and live fish
2	Cereal grains
3	Other agricultural products
4	Animal feed and products of animal origin, nec*
5	Meat, fish, seafood, and their preparations

Commodity flow in 1000 tons,
Land use = acres

Conclusion

- A wealth of data on freight/commodity flow is now available on-line to users at no cost.
- Land use is a governing factor that can be used for estimating the level of commodity flow.
- GIS is helpful to evaluate the level of relationship between commodity flow and land use types.
- The Peason correltaiton analysis showed that urban and residential land use types are closely correlated with all three commodity flow types.
- Mutiple regression models with relatively high R^2 values were obtained.

Recommendations

- Validate the models by estimating commodity flow in different states
- Make data broken down to county level when collecting freight data
- As the next step, study relationships between commodity flow and economic factors relavant to , such as number of jobs, employment data, and wage data, for which data are more readily available than land use type data.

Thank you!

Questions?

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