# FINDING RELATIONSHIPS BETWEEN COMMODITY FLOW AND LAND USE

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## ABSTRACT

The importance of commodity flow has significantly increased with the growth of economic activities; and traffic congestion, environmental pollution, and inadequate freight facilities produced by the growth of commodity flow have affected entire social systems, including transportation systems. Commodity produced from, attracted to, and distributed within a traffic analysis zone is affected by multiple contributing factors, such as land use, location, time, social condition, economic condition, and political condition. Of these factors, land use is considered to be one of the most important factors affecting the level of commodity flow. Transportation planners' and engineers' ability to predict commodity flow using land use data can help them quickly make rough estimates of future commodity flow and prepare for future transportation facility needs. Lack of comprehensive commodity flow and land use data has hindered this effort. However, these data are becoming available to the public via the Internet. This study took advantage of this data availability to evaluate relationships between commodity flow and land use, and found that there were strong relationships between commodity flow and land use. Based on the findings of correlation analysis, multiple regression models for estimating commodity flow using land use data were developed by stepwise regression for the state of Utah.

## 1. INTRODUCTION

Commodity flow has increased dramatically in the United States in the past decade. Because of this, the increase in truck traffic moving those commodities over US highways has created problems and challenges for transportation planning and traffic operation. These problems include traffic congestion, deficient transportation systems, insufficient truck parking spaces, increased traffic crashes involving trucks, deteriorating transportation infrastructure, environmental pollutions, and lower quality of life near truck routes.

Freight demand modeling requires a significant amount of data because it involves a comprehensive analysis of the relationships among economic activities, production and attraction trends by industry, distribution or linkages between production and attraction nodes, mode choice, shipment size decisions, vehicle trips, and route assignments. Dimensions that influence freight demand modeling (i.e., weight, volume, transport mode, and volume of freight traffic) have given rise to two major modeling platforms: commodity-based modeling and trip-based modeling [1].

It is widely accepted that fundamental economic mechanisms for specific regions drive freight movements, which are largely determined by attributes of land use for each analysis zone. In other words, how a region uses its land largely determines what commodities are shipped into, out of, or distributed within that region. Consequently, land use models for the transportation planning process are essential in understanding and predicting the location of current and future economic activities [2].

To better understand the characteristics of commodity flow in Utah, a study was conducted to determine the relationship between commodity flow and land use. Data about commodity flow in specific regions are now publicly available, to a certain extent, from organizations such as the Commodity Flow Survey (CFS) by the U. S. Census Bureau and the Bureau of Transportation Statistics [3], the Freight Analysis Framework (FAF) [4], Utah GIS portal data [5], and city and county data available from the Utah Governor's Office website [6].

This paper presents the results of an in-depth analysis of these databases and demonstrates that there are strong correlations between commodity flow and land use. Hence, when funds are limited for building sophisticated models for commodity flow just like the ones mentioned in the literature review, rough estimates of commodity flows can be made by using publicly available freight-related data. Although this paper uses Utah's data, the concept presented here should apply to any part of the world as long as commodity flow and land use data are available.

## 2. LITERATURE REVIEW

Corsi et al. [7] discussed key differences between passenger and freight transportation, including unit of measures, value of time, cost of loading and unloading, types of vehicle, and number of decision makers. Freight movement from an origin to a destination is determined by a number of key locations defined by where certain activities related to commodity flow take place, including production and attraction sites, warehouses, other intermediate distribution centers, and storage facilities. Also, freight movement is affected by the measurements of transported freight (volume, weight, transport mode, and volume of the items being transported) and by the decision makers about the items being transported (shippers, receivers, and carriers). In other words, the variables that determine how freight moves through the transport systems are complicated and intermingled with each other [8].

Ortuzer and Willumsen [9] studied the key factors affecting freight movements in the United Kingdom (UK) in 2002. They focused on location factors (resources, production, and intermediate and final market); physical factors (characteristics of new materials and products that influence the way they are transported); operational factors (the size of the firm, its distribution policy, and its geographical dispersion); dynamic factors (seasonal variations in demand and changes in customers' tastes); and pricing factors (changes in price of product including technology and political policy).

In the same year, Iding et al. [10] suggested examples of freight trip generation indicators by land use type in Germany through a large-scale postal and telephone survey. They surveyed types of core business (type of activity), site, floor area, and number of employees; the type of industrial site on which the firm is located; the average number of trucks per day bringing in and taking out freight (per type of vehicle); and other logistic characteristics like transport mode, transport distances of trucks, dispersion of trucks over time (day and week), loading units, and organization of transport. This study, however, did not include the evaluation of relationships between commodity flow and land use.

Even though several studies, including the Southern California Association of Government (SCAG)'s model and the Travel and Land Use Model Integration Program (TLUMIP) in the state of Oregon, have forecasted freight traffic demand using land use, these models did not use the direct relationship between commodity flow and land use. As a regional input-output (I-O) model, the SCAG's model used trip rates for each of eight different land use types using socioeconomic data inputs (households and employment by industry sector). Trip rates were calculated for each of three different truck gross-vehicle-weight classes [11]. TLUMIP used bi-level hybrid simulation methods that follow the changes of land use according to urban growth and forecast truck traffic according to travel demand by land use [12]. TLUMIP could be a land use model that interfaces with an existing travel demand model, or an integrated urban model that combines land development and travel models.

The existing models have resulted from the efforts of many researchers and practitioners, involving complex models and sophisticated procedures. These models, however, often require expert consultants to run. Given the availability of data on land use for a particular year and the commodity flow for that year, there can be a way for transportation planners and engineers to make rough estimates of commodity flow directly from land use data. With this simple question in mind, this study was conducted to evaluate the relationship between commodity flow and land use using a geographic information system in transportation (GIS-T) and statistical analysis tools.

## 3. METHODOLOGY

This section presents the data collection, reduction, and analysis procedures followed in this study. The analysis focuses on data that are publicly available via the Internet. The level of data availability is the key to completing the analysis.

### 3.1. Data collection and transformation

Data for this research were collected from government websites, including the CFS [3], the FAF [4], the Utah GIS Portal [5], and the official website for the state of Utah [6]. County Business Pattern (CBP) data for year 2002 were drawn from the FAF website [4]. The CFS website provided commodity flow survey results, including shipment characteristics by mode of transportation for origin state in the year 2002. The Utah GIS Portal had geographic map files and a geodata database organized by county. Utah population estimates for year 2002 and the profiles of social and economic characteristics of Utah were obtained from Utah's official state website. All raw data went through logarithmic transformation (natural log) in order to normalize the data distribution. In this study, counties were used as the traffic analysis zones because counties were the smallest areas that could be used for the analysis, due to the extent of available data. Statewide commodity flow totals produced from (production), attracted to (attraction), and distributed within Utah (within) by two-digit Standard Industrial Classification (SIC) code were allocated to each county using the proportion of the county total employment to the state total employment because CFS data are state-level summaries. Previous research studies found that employment data were closely related to the amount of commodity flow generated [10, 11].

This study analyzed relationships between commodity flow and land use, together with relationships between commodity flow and contributing economic factors, and the correlation between land use and business pattern factors for the subsequent analyses. However, this paper reports only the relationships established between commodity flow and land use.

### 3.2. Classification of data by industry code

The next step for organizing the data was to classify each type of commodity by industry code. Commodities produced in Utah and sent to other states (production), imported to Utah from other states (attraction), and transported to other counties within Utah (within) were classified into 44 industries by the SIC code. Commodity flow data obtained from the CFS website were classified into the 2002 Production Commodity from Utah (CFS2P) values, the 2002 Attraction Commodity to Utah (CFS2A) values, and the 2002 Commodity Flow within Utah (CFS2I) values. Table 1 lists the variable names used in the study that correspond to the classified commodity types.

Table 1 - Commodity classifications by two-digit SIC code for CFS2002

| SIC Code | Detailed Industries (nec = not elsewhere classified) | Production CFS2P | Attraction CFS2A | Within CFS2I |
|---|---|---|---|---|
| | All Commodities (Code T was used for analysis) | CFS2PT | CFS2AT | CFS2IT |
| 01 | Live animals and live fish | CFS2P1 | CFS2A1 | CFS2I1 |
| 02 | Cereal grains | CFS2P2 | CFS2A2 | CFS2I2 |
| 03 | Other agricultural products | CFS2P3 | CFS2A3 | CFS2I3 |
| 04 | Animal feed and products of animal origin, nec | CFS2P4 | CFS2A4 | CFS2I4 |
| 05 | Meat, fish, seafood, and their preparations | CFS2P5 | CFS2A5 | CFS2I5 |
| 06 | Milled grain products and preparations, and bakery products | CFS2P6 | CFS2A6 | CFS2I6 |
| 07 | Other prepared foodstuffs and fats and oils | CFS2P7 | CFS2A7 | CFS2I7 |
| 08 | Alcoholic beverages | CFS2P8 | CFS2A8 | CFS2I8 |
| 09 | Tobacco products | CFS2P9 | CFS2A9 | CFS2I9 |
| 10 | Monumental or building stone | CFS2P10 | CFS2A10 | CFS2I10 |
| 11 | Natural sands | CFS2P11 | CFS2A11 | CFS2I11 |
| 12 | Gravel and crushed stone | CFS2P12 | CFS2A12 | CFS2I12 |
| 13 | Nonmetallic minerals, nec | CFS2P13 | CFS2A13 | CFS2I13 |
| 14 | Metallic ores and concentrates | CFS2P14 | CFS2A14 | CFS2I14 |
| 15 | Coal | CFS2P15 | CFS2A15 | CFS2I15 |
| 17 | Gasoline and aviation turbine fuel | CFS2P17 | CFS2A17 | CFS2I17 |
| 18 | Fuel oils | CFS2P18 | CFS2A18 | CFS2I18 |
| 19 | Coal and petroleum products, nec | CFS2P19 | CFS2A19 | CFS2I19 |
| 20 | Basic chemicals | CFS2P20 | CFS2A20 | CFS2I20 |
| 21 | Pharmaceutical products | CFS2P21 | CFS2A21 | CFS2I21 |
| 22 | Fertilizers | CFS2P22 | CFS2A22 | CFS2I22 |
| 23 | Chemical products and preparations, nec | CFS2P23 | CFS2A23 | CFS2I23 |
| 24 | Plastics and rubber | CFS2P24 | CFS2A24 | CFS2I24 |
| 25 | Logs and other wood in the rough | CFS2P25 | CFS2A25 | CFS2I25 |
| 26 | Wood products | CFS2P26 | CFS2A26 | CFS2I26 |
| 27 | Pulp, newsprint, paper, and paperboard | CFS2P27 | CFS2A27 | CFS2I27 |
| 28 | Paper or paperboard articles | CFS2P28 | CFS2A28 | CFS2I28 |
| 29 | Printed products | CFS2P29 | CFS2A29 | CFS2I29 |
| 30 | Textiles, leather, and articles of textiles or leather | CFS2P30 | CFS2A30 | CFS2I30 |
| 31 | Nonmetallic mineral products | CFS2P31 | CFS2A31 | CFS2I31 |
| 32 | Base metal in primary or semi-finished forms and in finished basic shapes | CFS2P32 | CFS2A32 | CFS2I32 |
| 33 | Articles of base metal | CFS2P33 | CFS2A33 | CFS2I33 |
| 34 | Machinery | CFS2P34 | CFS2A34 | CFS2I34 |
| 35 | Electronic and other electrical equipment and components and office equipment | CFS2P35 | CFS2A35 | CFS2I35 |
| 36 | Motorized and other vehicles (including parts) | CFS2P36 | CFS2A36 | CFS2I36 |
| 37 | Transportation equipment, nec | CFS2P37 | CFS2A37 | CFS2I37 |
| 38 | Precision instruments and apparatus | CFS2P38 | CFS2A38 | CFS2I38 |
| 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 |

## 3.3. Analysis process

The process shown in Figure 1 was followed in order to analyze the relationship between commodity flow and land use using SPSS [13] and TransCAD [14]. Data collected for the analyses were sorted and reduced using a Microsoft Excel spreadsheet, and analyzed and modelled using SPSS and TransCAD.

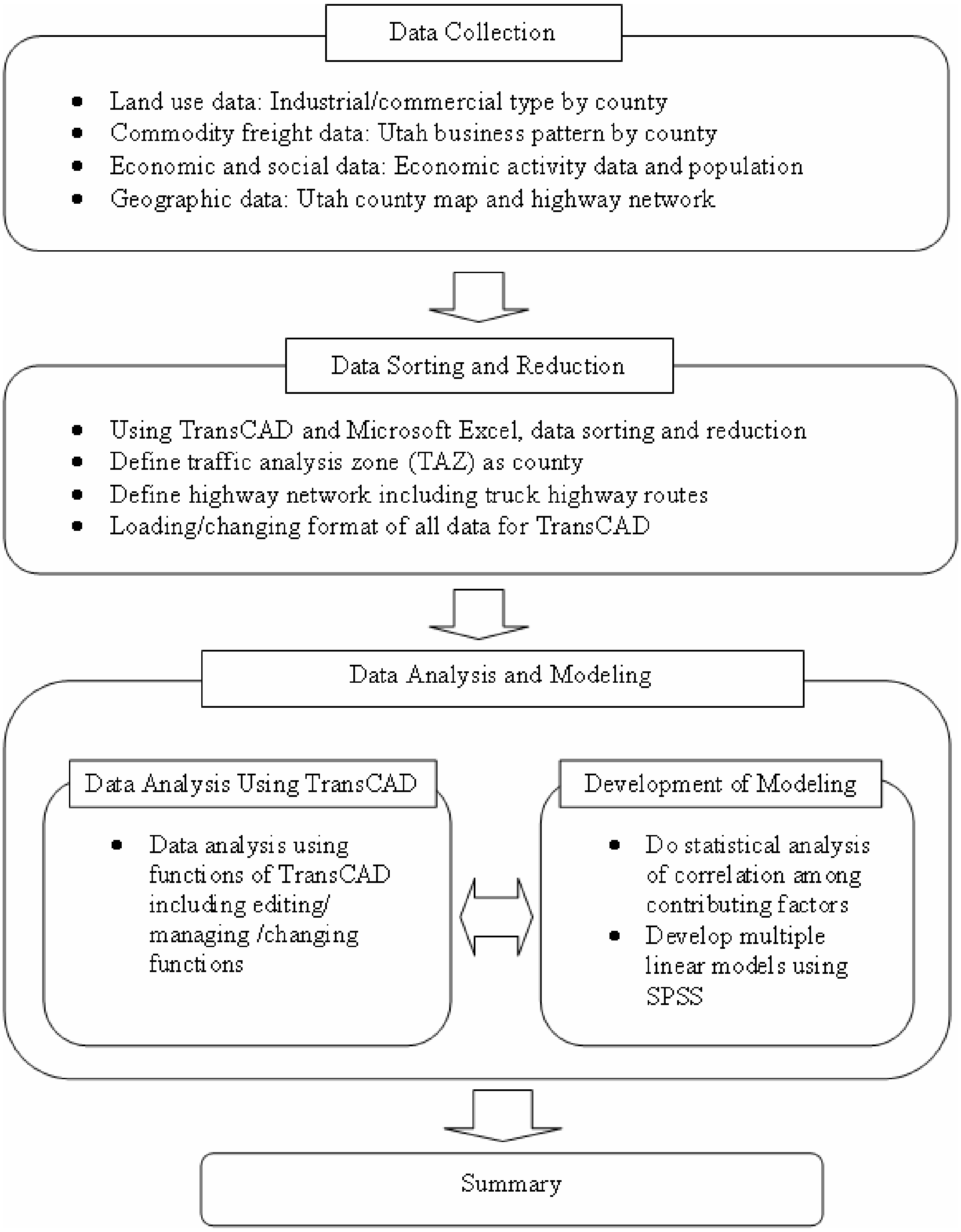


Figure 1 - Analysis process

## 4. ANALYSIS RESULTS

Results of analyses using SPSS [13] and TransCAD [14] are presented in this section, including the results of Pearson correlation analysis between commodity flow and land use, GIS maps showing relationships between commodity flow and land use, and multiple regression models with commodity flow as the dependent variable (in thousand tons) and land use types (in acres) as independent variables. The analyses show that there are good correlations between commodity flow and land use.

### 4.1. Correlation between commodity flow and land use

Correlation analysis between commodity flow and land use was performed to see if there is a close relationship between commodity flow and land use. There are six land use types: irrigation area (IR), non-irrigation area (NI), residential area (RES), riparian (RIP), urban area (URB), and water area (Water) in the Utah GIS Portal data set [5]. Table 2 shows the Pearson correlation values between total commodity flow and land use. It was found that residential land use (RES) had the closest correlation with commodity flow, with a Pearson correlation value of about 0.91. Land use with the second highest Pearson correlation value was urban land use (URB), with a Pearson correlation value of about 0.86. Non-irrigation and riparian areas had much less correlation with commodity flow. Their relationships were significant at the 95 percent confidence level (α = 0.05).

Table 2 - Correlations between commodity flow and land use

| | | **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 |

(Unit: Commodity flow in thousand tons; Land use in acres)

### 4.2. Geographic analysis

All data related to the contributing factors can be placed on the Utah map by using the geographic analysis functions of TransCAD, such as merging, making bands, overlaying, and showing areas of influence. Also, analysis and presentation functions of various theme maps of TransCAD such as color pattern, dot-density, pie and bar chart, and scaled-symbol themes, enable the user to perform multiple geographical map analyses [14]. Figure 2 demonstrates the results of correlation analysis among commodity flow and land use type.

Figure 2 shows a color and pattern theme map with pie-charts describing the relationship between commodity flow and land use type. The larger the size of urban area, the higher the commodity flow. Therefore, the area size of urban land use is a good variable for estimating the amount of commodity flow. As shown in Figure 2, most of the commodity flows produced from, attracted to, and distributed within Utah are concentrated in three urban areas in Utah: the Wasatch Front (Salt Lake County, Utah County, and Davis County), northern Utah (Weber County and Cache County), and southern Utah (Washington County).

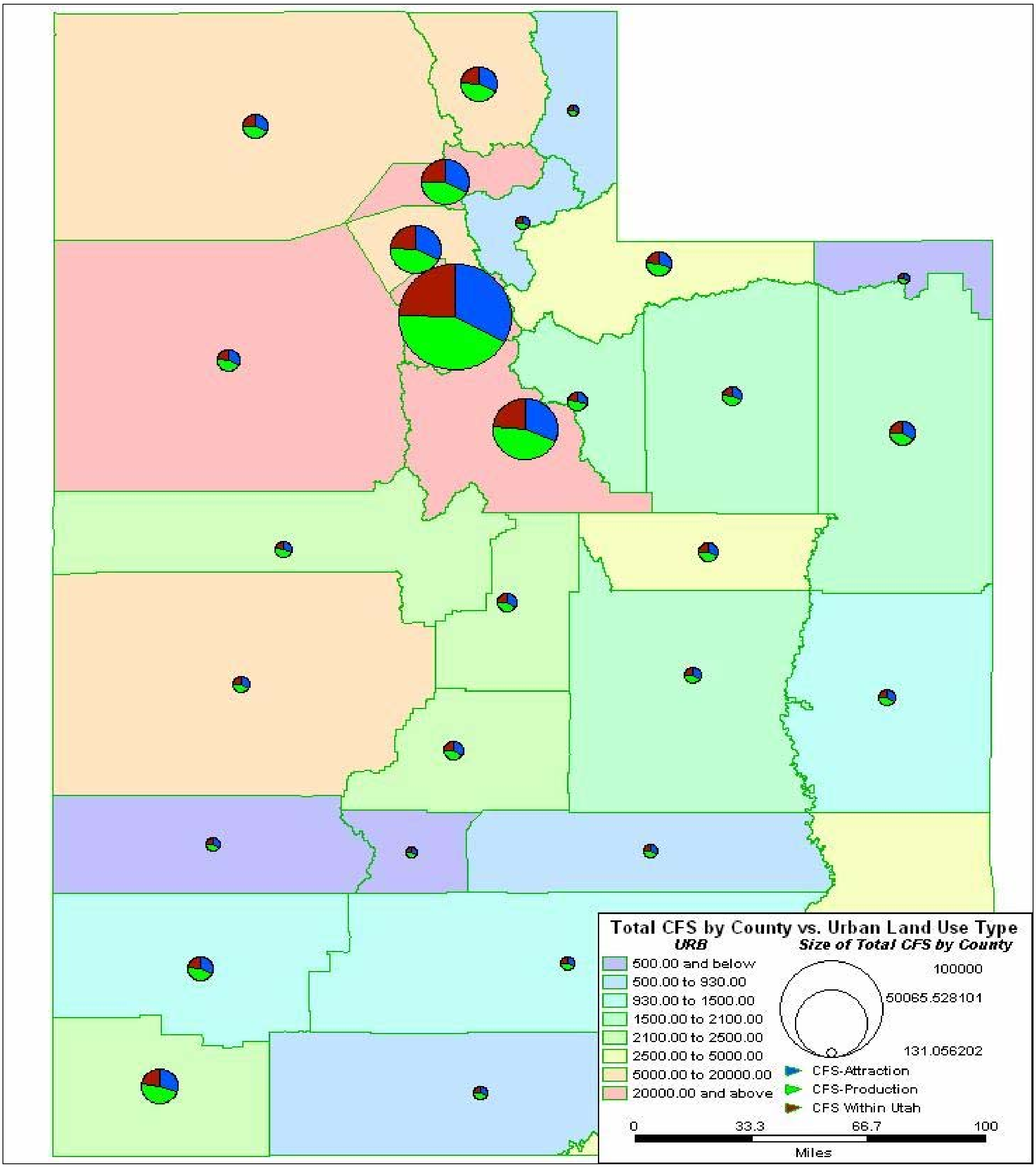


Figure 2 - Map of total CFS and URB by county

4.3. Multiple linear regression analysis

Based on the findings from the correlation analysis, potential variables that would be included in multiple linear regression models were identified by stepwise regression analysis. Multiple regression models were developed for each commodity type to estimate the level of commodity flow per county for production of, attraction to, and within Utah commodity flow using the two-digit SIC code. The general model used for the analysis is shown below, where *i* is the commodity type number and *j* is the land use type number (see Table 2). CFS2P in the model means year 2002 commodity flow for production. For attraction and within commodity flow, P in CFS2P is replaced by A and I, respectively.

$$\ln(CFS2P_i) = Constant_i + \sum_{j=1}^{6} a_{ij} \ln(Land\ Use\ Type_j) \qquad \text{Equation (1)}$$

Figure 3 shows an example of the results of stepwise regression analysis on SIC 34 (machinery) for attraction; three best models are shown in the figure. As shown in the figure, $R^2$ values were found to be quite high (0.831 to 0.925 in this example), indicating a strong relationship between commodity flow and land use type.

**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

Figure 3 - Commodity flow-attraction for commodity item 34 (CFSTA34)

Ramsey and Schafer [15] state that the model selection can be based directly on the key statistical parameter values, including use of the number of explanatory variables to model the response accurately, without the loss of precision that occurs when essentially redundant and unnecessary terms are included. Even though the $R^2$ of each model was automatically calculated as the SPSS statistical summary, the $R^2$ cannot be used as is because it is not adequate for making a sensible selection of the cases presented. As a method of selecting the best regression model, Schwarz's Bayesian Information Criterion (BIC) was used. The smaller the value of BIC a model has, the better the model is [15].

Through the stepwise multiple regression, each commodity flow type (production from, attraction to, and distributed within Utah) by two-digit SIC code was analyzed. Models with the best fit, as evaluated by BIC, were chosen for each commodity type. Table 3 through Table 5 show selected multiple regression models with land use type for CFS-Attraction, CFS-Production, and CFS-Within Utah by two-digit SIC code. Even though the models between commodity flow and land use type cannot be validated with real data due to the lack of future land use data at the time of this study, the models suggest that there is a strong relationship between commodity flow and land use. In these tables, constants are all near zero, indicating that there is no commodity flow when predictor values are zero.

## 5. CONCLUSION

Levels of commodity flow produced from, attracted to, and distributed within Utah are a function of location, physical attributes, operation, and pricing. Land use is a governing factor that can be used for estimating the level of commodity flow. Better prediction of land use will enable transportation planners to more quickly estimate commodity flow and plan for the development of future transportation facilities. Now that commodity flow data, land use data, and other data necessary for this type of analysis are available via the Internet, it is possible to study the relationship between commodity flow and land use.

Understanding the relationship between commodity flow and land use is a fundamental step for estimating the level of commodity flow. This study found that the land use types most closely related to the level of commodity flow were urban and residential land use types. The Pearson correlation values of these two land use types for the three commodity flow types were high, as shown in Table 2. Geographical map analysis functions of TransCAD were also used in the study to clearly illustrate the relationship between levels of commodity flow and land use, as shown in Figure 2.

Multiple linear regression models were then developed by stepwise regression analysis to find relationships between commodity flow and land use using the two-digit SIC code. When future land use plans become available, commodity flow produced from, attracted to, and distributed within Utah can be predicted by macroscopic regression models because the models developed in this study are quite reliable, with high $R^2$ values, as shown by sample models in Figure 3.

This paper discussed a procedure for finding relationships between commodity flow and land use specifically for the state of Utah. Although this paper uses Utah's data, the concept presented here should apply to any part of the world as long as core data of commodity flow and land use become available.

The next recommended steps are to study relationships between commodity flow and economic factors relevant to land use, such as number of jobs, employment data, and wages data, and to develop multiple regression models to estimate commodity flow using economic factors.

Table 3 – Coefficients of best multiple linear regression models with land use types for CFS-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 |
| CFSTP6 | 0.0000400626 | 3.5137 | 1.6226 | 0.7299 | |
| CFSTP7 | 0.0000661411 | 3.5272 | 1.6231 | 0.7286 | |
| CFSTP8 | 0.0000048204 | 3.6764 | 1.6287 | 0.7156 | |
| CFSTP12 | 0.0001648088 | 2.9842 | 1.8642 | 0.7015 | |
| CFSTP13 | 0.0001681593 | 3.4329 | 1.6195 | 0.7373 | |
| CFSTP15 | 0.0006585555 | 3.5948 | 1.6257 | 0.7226 | |
| CFSTP17 | 0.0002522777 | 3.5530 | 1.6241 | 0.7263 | |
| CFSTP18 | 0.0001264083 | 4.5880 | | | |
| CFSTP19 | 0.0002029898 | 3.2926 | | | |
| CFSTP21 | 0.0000006530 | 4.3171 | | | 1.1156 |
| CFSTP22 | 0.0000029770 | 4.3171 | | | 1.1156 |
| CFSTP23 | 0.0000195904 | 3.7160 | 1.6302 | 0.7123 | |
| CFSTP24 | 0.0000529435 | 3.2995 | | | |
| CFSTP25 | 0.0000003737 | 4.3172 | | | 1.1156 |
| CFSTP26 | 0.0000364609 | 3.5758 | 1.6250 | 0.7243 | |
| CFSTP27 | 0.0000033302 | 3.3863 | 1.6176 | 0.7417 | |
| CFSTP28 | 0.0000184642 | 3.3057 | 1.6144 | 0.7495 | |
| CFSTP29 | 0.0000217639 | 3.3653 | | | |
| CFSTP30 | 0.0000014188 | 4.3181 | 1.6507 | 0.6672 | |
| CFSTP31 | 0.0000776226 | 4.3172 | | | 1.1156 |
| CFSTP32 | 0.0004442777 | 3.4695 | | | |
| CFSTP33 | 0.0000043250 | 4.3172 | | | 1.1156 |
| CFSTP34 | 0.0000177194 | 3.1800 | 1.6092 | 0.7622 | |
| CFSTP35 | 0.0000036229 | 3.9239 | 1.6376 | 0.6956 | |
| CFSTP36 | 0.0000017570 | 4.3172 | | | 1.1156 |
| CFSTP37 | 0.0000000172 | 4.3172 | | | 1.1156 |
| CFSTP38 | 0.0000002019 | 4.3172 | | | 1.1156 |
| CFSTP39 | 0.0000317855 | 3.1372 | | | |
| CFSTP40 | 0.0000304324 | 2.9842 | 1.8642 | 0.7015 | |
| CFSTP42 | 0.0000089661 | 4.3171 | | | 1.1156 |
| CFSTP43 | 0.0003515399 | 3.3549 | | | |

TABLE 4 - Coefficients of best multiple linear regression models with land use types for CFS-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 | |
| CFSTA6 | 0.000024856 | 3.5976 | 1.6220 | 0.7259 | |
| CFSTA7 | 0.000136632 | 3.2330 | 1.6076 | 0.7604 | |
| CFSTA8 | 0.000011096 | 3.4768 | 1.6174 | 0.7368 | |
| CFSTA11 | 0.000012136 | 2.9433 | 1.8555 | 0.7096 | |
| CFSTA12 | 0.001406241 | 3.0402 | | | |
| CFSTA13 | 0.000021974 | 3.9989 | 1.6364 | 0.6932 | |
| CFSTA14 | 0.000086220 | 3.1923 | | | |
| CFSTA15 | 0.000689348 | 3.4205 | 1.6152 | 0.7420 | |
| CFSTA17 | 0.000263673 | 3.4181 | 1.6151 | 0.7422 | |
| CFSTA18 | 0.000166701 | 4.2942 | | | |
| CFSTA19 | 0.000202669 | 3.4839 | | | |
| CFSTA20 | 0.000004640 | 4.3172 | | | 1.1156 |
| CFSTA21 | 0.000002527 | 4.6053 | | | |
| CFSTA22 | 0.000001310 | 4.3172 | | | 1.1156 |
| CFSTA23 | 0.000017020 | 3.5556 | 1.6205 | 0.7296 | |
| CFSTA24 | 0.000118237 | 3.3664 | | | |
| CFSTA26 | 0.000072943 | 3.3150 | 1.6110 | 0.7522 | |
| CFSTA27 | 0.000031592 | 3.1548 | 1.6044 | 0.7686 | |
| CFSTA28 | 0.000042201 | 3.4857 | | | |
| CFSTA29 | 0.000025818 | 3.4770 | | | |
| CFSTA30 | 0.000010629 | 3.4073 | 1.6147 | 0.7433 | |
| CFSTA31 | 0.002273012 | 2.9671 | | | |
| CFSTA32 | 0.000127399 | 3.0987 | 1.6020 | 0.7746 | |
| CFSTA33 | 0.000035883 | 3.2849 | 1.6098 | 0.7552 | |
| CFSTA34 | 0.000015952 | 3.4478 | 1.6164 | 0.7394 | |
| CFSTA35 | 0.000011177 | 3.0573 | 1.6002 | 0.7792 | |
| CFSTA36 | 0.000020751 | 3.3626 | 1.6129 | 0.7475 | |
| CFSTA37 | 0.000000095 | 4.3172 | | | 1.1156 |
| CFSTA39 | 0.000014201 | 3.4055 | | | |
| CFSTA40 | 0.000031446 | 3.2167 | 1.6070 | 0.7621 | |
| CFSTA43 | 0.000149715 | 3.0237 | 1.5987 | 0.7829 | |
| CFSTA99 | 0.000006269 | 2.9433 | 1.8555 | 0.7096 | |

TABLE 5 - Coefficients of best multiple linear regression model with land use types for CFS-Within

| 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 |
| CFSTI6 | 0.00001614 | 3.3465 | 1.6123 | 0.7491 | |
| CFSTI7 | 0.00003867 | 3.5615 | 1.6207 | 0.7291 | |
| CFSTI8 | 0.00000509 | 3.6162 | 1.6227 | 0.7243 | |
| CFSTI12 | 0.00016109 | 2.9433 | 1.8555 | 0.7097 | |
| CFSTI13 | 0.00004124 | 2.9433 | 1.8555 | 0.7096 | |
| CFSTI14 | 0.00001392 | 2.9433 | 1.8555 | 0.7096 | |
| CFSTI15 | 0.00054814 | 3.4531 | 1.6165 | 0.7389 | |
| CFSTI17 | 0.00024517 | 3.4283 | 1.6155 | 0.7413 | |
| CFSTI18 | 0.00012282 | 4.4113 | | | |
| CFSTI19 | 0.00017090 | 3.2594 | | | |
| CFSTI20 | 0.00000210 | 4.3171 | | | 1.1156 |
| CFSTI21 | 0.00000192 | 4.4076 | | | |
| CFSTI22 | 0.00000042 | 4.3171 | | | 1.1156 |
| CFSTI23 | 0.00000056 | 4.3172 | | | 1.1156 |
| CFSTI24 | 0.00000135 | 4.3171 | | | 1.1156 |
| CFSTI25 | 0.00000037 | 4.3172 | | | 1.1156 |
| CFSTI26 | 0.00003767 | 3.2322 | 1.6076 | 0.7605 | |
| CFSTI27 | 0.00000354 | 3.2163 | 1.6069 | 0.7621 | |
| CFSTI28 | 0.00002348 | 3.3731 | | | |
| CFSTI29 | 0.00000293 | 2.9433 | 1.8555 | 0.7096 | |
| CFSTI30 | 0.00000005 | 4.3172 | | | 1.1156 |
| CFSTI31 | 0.00211310 | 2.8753 | | | |
| CFSTI32 | 0.00009562 | 3.0480 | 1.5998 | 0.7801 | |
| CFSTI33 | 0.00003244 | 3.4639 | | | |
| CFSTI34 | 0.00001103 | 3.1616 | 1.6047 | 0.7676 | |
| CFSTI35 | 0.00000832 | 3.1130 | | | |
| CFSTI36 | 0.00000026 | 4.3172 | | | 1.1156 |
| CFSTI38 | 0.00000003 | 4.3172 | | | 1.1156 |
| CFSTI39 | 0.00000020 | 4.3172 | | | 1.1156 |
| CFSTI40 | 0.00001359 | 3.0725 | 1.6008 | 0.7775 | |
| CFSTI41 | 0.00000847 | 4.3172 | | | 1.1156 |
| CFSTI43 | 0.00022255 | 3.3139 | | | |

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