Development of a Freight Database for Use in Allocating Freight Traffic to Sub-State Traffic Zones

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ABSTRACT

The use of national freight data at the local level is challenging due to the high level of aggregation and because freight data is proprietary. Many national freight databases aggregate information to the individual states or major communities. Most methods of utilizing freight data depend on applying proxy factors to allocate the freight to the system. The planning factors used in freight system analysis must be capable of describing the freight generation and attraction characteristics of the region. The use of employment as a planning factor has come under scrutiny mainly due to the inability of the factor to accurately estimate the effect of productivity improvements made by a company to increase production without increasing employment.

This research has shown that local economic data from many different sources can successfully be used to allocate freight volume into smaller zones from the future freight traffic volumes provided by highly aggregated national databases. The output of this effort is used as input to the modeling of freight, and the integration of that freight into existing transportation planning and modeling activities at the state and local level. This has been accomplished in Alabama at the statewide and metropolitan planning organization level, resulting in validated transportation models that integrate freight into the planning activity. The methodology described in this paper can easily be replicated by other states and metropolitan planning organizations.

INTRODUCTION

The basis of any reasonable predictor of freight activity in an area is the availability of accurate and verifiable data. Freight planning in the United States has traditionally been performed by applying backward-looking data analysis and forward-projecting trend line forecasting. This method of data development and analysis is wholly inadequate for the economic environment of today. At best, trend line forecasting assumes that whatever has happened in the past will be replicated in the future.

As an alternative to trend line analysis, if the underlying principles of freight demand generation can be discovered for a particular industry, the ability to accurately predict freight demand on the transportation system would be improved. Most all methods of utilizing freight data depend on applying proxy factors to allocate the freight on the system [1]. The planning factors used in freight system analysis must be capable of describing the freight generation and attraction characteristics of the region.

It is difficult to incorporate freight information into transportation models and plans because freight data is proprietary and the release of that data is considered to be detrimental to the company's competitive position. In the United States, many national freight databases aggregate information to the individual states, or major communities in the states. An example is the Freight Analysis Framework, Version 2 Database (FAF2), developed and distributed by the Federal Highway Administration (FHWA).

The use of national freight data at the local level is challenging due to the high level of aggregation. In most instances the disaggregation of freight data from national levels for use in local areas has been based on the factor "employment" by prorating the employment in the local area to the to the total employment in the study region. The use of employment as a planning factor has come under scrutiny due to the inability of the factor to accurately estimate the effect of productivity improvements to increase production without increasing employment.

Under the FAF2 Commodity Origin-Destination (O-D) Database, the US is divided into 131 separate traffic zones, 17 of which are the major freight entry points into the country [2]. The remaining 114 regions are either those defined to include one or more major Metropolitan Statistical Areas (MSA) or Consolidated Statistical Areas (CSA) or those that lie outside of these MSA's and CSA's. Alabama is divided into two such zones – the Birmingham CSA and the remainder of the state. This geographical division does not give enough detail to forecast future freight movements within the state, so a way had to be found to allocate to substate freight analysis zones (FAZ's) incoming and outgoing traffic assigned to Alabama in the FAF2 Commodity O-D Database [3].

RELATED RESEARCH

Estimation of freight demand has most often relied upon driver surveys, which can be expensive, or some other method of piecing together fragments of information from multiple sources [4]. This lack of data is explained, in part, by the level of complexity in the freight system itself, with multiple individual players that must interact and the costs associated with gathering the data which for profit companies deem proprietary [5].

The need to estimate freight demand and its relationship to the freight transportation supply are critical in any effort to model the overall system. In 2000, Pendyala, et al., compiled a synthesis of approaches for freight system analysis investigating the factors that affect freight demand [6].

A SUBSTATE DATABASE FOR ALABAMA

The high level of aggregation in the publicly available national databases is not conducive to analyzing the effect of freight on the transportation infrastructure at the state or local level. As a result, the data has limited use for state or local transportation planning activities.

The ability to plan and forecast freight demand is limited by the lack of available data at the level of detail that is meaningful to the transportation planner. Disaggregation of the data to a more detailed level is required to apply the freight flow data to whatever substate planning level under consideration. The fundamental problem is how to disaggregate the data to a usable level, without reducing the quality of the data to a point where its use would introduce excessive error [3].

Geographical Basis for Alabama's Substate Database

Two criteria were used to choose the geographical basis of the substate database. The criteria were the availability of local socioeconomic information and the number of resulting substate FAZ's. Most routinely published socioeconomic data is based on counties. Alabama contains 67 counties so arranging this information by county would be relatively easy and would still give a much more detailed picture of intrastate freight traffic movement than using just the two traffic zones provided by the FAF2 O-D matrices. Using counties also would allow for higher levels of aggregation in order to reduce the complexity of allocating freight traffic to all 67 counties.

Combining Economic and Freight Movement Data

Freight in the FAF2 Commodity O-D Database is defined by the Standard Classification of Transported Goods (SCTG) [7]. Most economic data is classified by the North American Industrial Classification System (NAICS). These two classification systems must be melded together as closely as possible in order to provide the transportation planner with enough detail to allocate traffic by industrial sector, if needed. The matchup of SCTG's and NAIC's classifications are provided in Table 1. Of the 43 SCTG codes, 14 have counterparts under the NAICS classification at the three digit level. The 14 are highlighted in bold in the table. In other cases either the SCTG or the three digit NAICS classifications offer more detail. For example, the three digit food processing classification under NAICS encompasses four separate SCTG categories. The textile and apparel SCTG category includes three different NAICS codes. Despite the loss of detail these mismatches create, the combined categories still allow for substantial industrial detail in the substate database and consequently a more reliable freight allocation among the substate FAZ's. Two of the SCTG categories – mixed freight; and waste and scrap – have no NAICS counterparts and must be estimated separately using other sources such as company surveys. Figure 1 presents the different data sets utilized in this research, the manner of use and the interactions of the data to produce input for use by transportation planners as input for their particular models and planning activities.

Determining a County's Economic Base

Each county's economic base must be defined in order to properly gauge the amount of future freight traffic that will be entering and leaving. For freight modeling purposes, the economic base can be defined as all goods producing industries within a county. For Alabama counties, the economic base includes major manufacturing industries, agriculture, logging, and mining (Figure 1). Each of these industries can potentially generate both incoming and outgoing freight traffic. Retailing, wholesaling and warehousing activity (Figure 1) can also create inbound traffic for sales to households and businesses within a county or outbound traffic for sales to households and businesses located elsewhere.

TABLE 1 SCTG Code Matchup With NAICS Codes

SCTG Code	Name	NAICS Code	Name
1	**Animals**	**111**	**Animals**
2	**Grains**	**112**	**Grains**
3	Other		
4 5 6 7	Animal Feed Meat, Seafood Bakery Goods Other	311	Food Processing Food Processing Food Processing Food Processing
8 9	Alcohol Tobacco	312	Alcohol, Tobacco Alcohol, Tobacco
10 11 12 13 14 **15**	Stone Sand Gravel Non-metallic Minerals Metallic Ores **Coal**	212	Stone, Clay, Gravel Stone, Clay, Gravel Stone, Clay, Gravel Stone, Clay, Gravel Stone, Clay, Gravel **Coal**
16	**Crude Oil**	**211**	**Petroleum**
17 18 19	Gasoline Fuel Oils Other	324	Refineries Refineries Refineries
20 21 22 23	Basic Chemicals Pharmaceuticals Fertilizers Other	325	Chemicals Chemicals Chemicals Chemicals
24	Plastics	326	Plastics
25	**Logs**	**113**	**Logs**
26	**Wood Products**	**321**	**Wood Products**
27 28	Pulp, Newsprint Paper	322	Paper Paper
29	**Printed Products**	**323**	**Printed Products**
30	Textiles & Apparel	313 314 315	Textile Mills Textile Products Apparel
31	**Nonmetallic Mineral Products**	**327**	**Nonmetallic Mineral Products**
32	**Primary Metals**	**331**	**Primary Metals**
33	**Fabricated Metals**	**332**	**Fabricated Metals**
34	**Machinery**	**333**	**Machinery**
35	Electronics & Electrical Equipment	334 335	Electronics Electrical Equipment
36	Motor Vehicles	336	Transportation Equip
37	Transportation Equip	336	Transportation Equip
38	**Instruments**	**339**	**Instruments**
39	**Furniture**	**337**	**Furniture**
40	**Misc. Manufacturing**	**339**	**Misc. Manufacturing**
41	Waste & Scrap		
42	Unknown		
43	Mixed Freight		

Determining the Base Year

The base year for the substate economic database is 2002, the year corresponding to the FAF2 O-D matrices. The year 2002 is also when the US Census Bureau surveys industries for its series of state economic censuses including the *Census of Manufacturing, the Census of Agriculture*, and the *Census of Mining* (Figure 1). The base year will change after the 2007 O-D matrices are released.

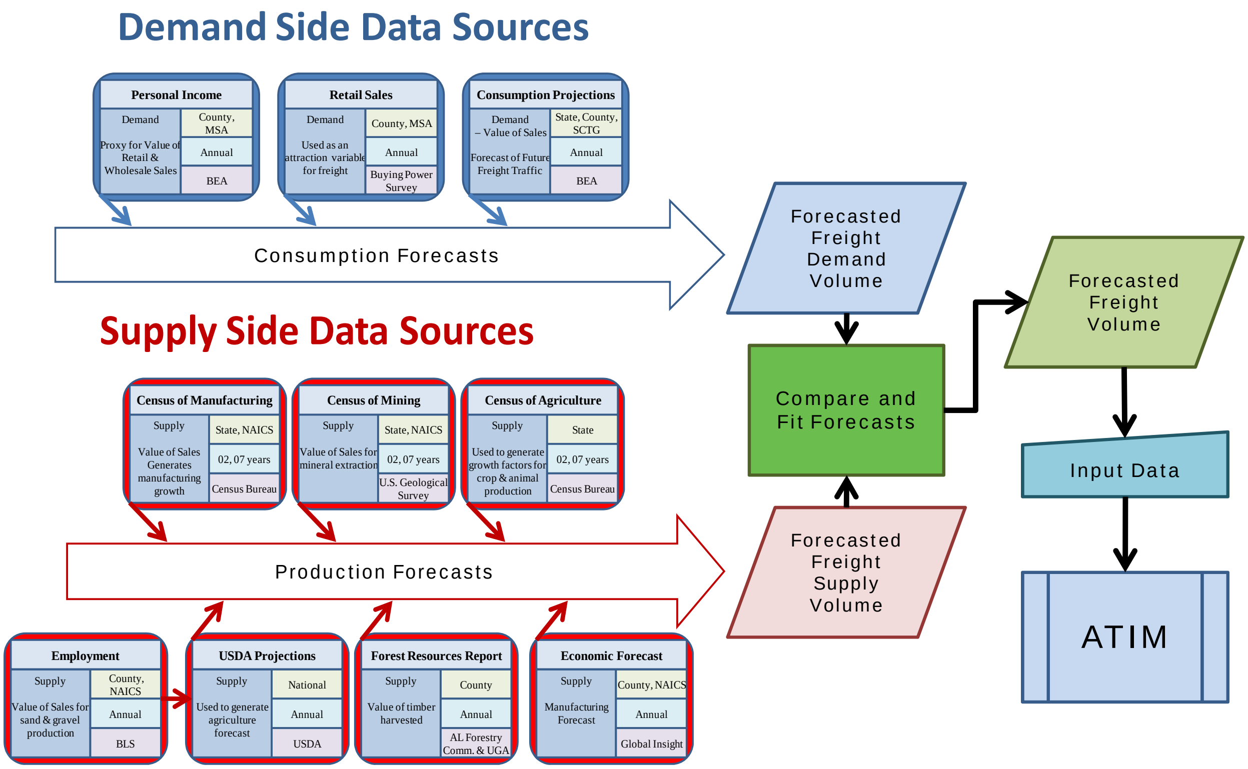

FIGURE 1 Data Sets and Interactions

Determining Variables to Use to Allocate Freight Traffic to Substate FAZ's

Heretofore, employment growth has typically been used to generate a freight traffic forecast in a particular area. However, employment growth has been shown to be a poor predictor of freight traffic increases because it doesn't take into account productivity improvements in goods producing industries [8]. The Value of Sales or Shipments has been shown to be a better predictor of freight generation activity. Thus, the Alabama substate economic database includes the value of sales from goods producing industries (Figure 1). Using value of sales instead of employment factors in future productivity improvements and consequently should provide a better forecast of future freight traffic.

Personal income was chosen to proxy the value of retail and wholesale sales to households and businesses in a substate region (Figure 1). The growth of personal income is highly correlated with the growth of household consumption expenditures and consequently should give a more accurate forecast than either population or employment growth.

Estimating the Value of Sales and Personal Income

The value of sales for manufacturing are published in the *Census of Manufacturing* (Figure 1) for each state, metropolitan area, and county that contains manufacturing enterprises [9]. If there are only a few manufacturers or one or two dominant firms, the value of sales data will be suppressed to protect the privacy of the firms. In Alabama the value of sales data was suppressed in 19 of 67 counties – nearly all of them small rural counties with a single dominant company. An estimate must be prepared in these cases. Generally the Census Bureau will provide a range of employment for the plant(s) in these counties. Taking the mid-point in the employment range and multiplying it by the average value of sales per employee for the industry as a whole within the state will give a good proxy for the actual value of sales in these counties. The value of sales in each county, including the ones for which estimates had to be made, can then be summed and compared to the actual total value of sales for the state. If the published total is larger or smaller than the total containing the estimates, the estimates can be increased or reduced until they equal the published state total.

The *Census of Agriculture* (Figure 1) provides detailed value of sales data for each type of crop or animal sold from a particular county [10]. The US Geological Survey (USGS) periodically publishes a state geological survey which includes the value of sales for the mineral industry [11]. The most recent USGS survey for Alabama was done in 2003. Production and sales data are provided by geological area rather than by county in this publication so it must be supplemented by information from the *Census of Mining* (Figure 1) to allocate the value of mineral extraction to each county in the state [12].

Smaller sand and gravel operations are located in almost every Alabama county. They can be found using *County Business Patterns* (Figure 1) where the publication lists total employment by county in this sector [13]. Allocating sand and gravel sales by employment give an estimate of the contribution of the sand and gravel industry to total sales in each county.

The physical amount of logs harvested in each county is released in an annual report (Figure 1) from the Alabama Forestry Commission [14]. The data are provided by type of log and by volume in board feet. The value of these logs was determined by translating board feet into tons and using 2002 pricing data for the South published by the Daniel B. Warnell School of Forestry Resources, University of Georgia [15].

Personal income (Figure 1) by county is released annually by the Bureau of Economic Analysis (BEA), US Department of Commerce. It is a part of BEA's Regional Economic Accounts database [16].

Projecting Value of Sales and Personal Income

Various sources can be used to project the value of sales and personal income from the base year to the end year (Figure 1). The Alabama substate economic database includes industry and county specific projections to the year 2035. They are derived from a series of 30 year national production index projections prepared quarterly by Global Insight [17]. These projections cover all NAICS codes except animals and crops. National projections of crop and animal sales are provided by the US Department of Agriculture (Figure 1) and can be found on their website [18]. Since the projections are published for just a ten year period, they have to be extended another 20 years to make them comparable to the rest of the projections in the database. A simple ordinary least squares (OLS) regression equation for each crop and animal type was used for this purpose.

A projection of personal income growth to the year 2035 was prepared for each Alabama County using an OLS regression equation and annual personal income data for that County over the time period 1975 through 2005. A few Alabama counties have recently experienced very rapid personal income growth which skewed the results of the regression analysis in an upward direction. In these cases, projected income growth in the out years was reduced by forcing the growth rate to converge with the US projected rate.

The methods described above provide a unique 30 year projection of value of sales and personal income for each county in Alabama. The projection is based on each county's mix of commodity-producing industries and historical personal income growth. The techniques allow for a county's share of future freight traffic to change significantly over the 30 year period based on its economic growth rate compared to the other counties in the state.

Table 2 displays the projected change in the freight allocation for each Alabama county between 2005 and 2035. It is based on weighting the value of sales and personal income equally and is expressed as a percentage of total projected freight traffic. Counties highlighted in bold in the table are projected to significantly increase their share of freight traffic between 2005 and 2035. The largest such increase is for Madison County where the share grows from 8.4% to 12.6%. Madison County's share grows so fast because of its mix of rapidly expanding high tech industries along with continuing strong growth in personal income. Other counties projected to increase their shares of freight traffic over the 30 year period include Baldwin, Elmore, Limestone, Morgan, Shelby, and Tuscaloosa.

TABLE 2 Change in the Allocation of Freight Traffic: 2005-2035

County	2005 Allocation		County	2035 Allocation
Autauga	0.7%		Autauga	0.8%
Baldwin	**2.8%**		**Baldwin**	**3.8%**
Barbour	0.7%		Barbour	0.6%
Bibb	0.2%		Bibb	0.2%
Blount	0.6%		Blount	0.7%
Bullock	0.2%		Bullock	0.2%
Butler	0.3%		Butler	0.2%
Calhoun	2.6%		Calhoun	2.4%
Chambers	0.8%		Chambers	0.3%
Cherokee	0.4%		Cherokee	0.3%
Chilton	0.6%		Chilton	0.5%
Choctaw	0.7%		Choctaw	0.5%
Clarke	0.6%		Clarke	0.4%
Clay	0.3%		Clay	0.3%
Cleburne	0.3%		Cleburne	0.1%
Coffee	0.9%		Coffee	1.0%
Colbert	1.4%		Colbert	1.1%
Conecuh	0.2%		Conecuh	0.2%
Coosa	0.2%		Coosa	0.1%
Covington	0.7%		Covington	0.7%
Crenshaw	0.3%		Crenshaw	0.2%
Cullman	1.4%		Cullman	1.4%
Dale	0.5%		Dale	0.4%
Dallas	1.1%		Dallas	0.8%
De Kalb	1.7%		De Kalb	1.2%
Elmore	**1.0%**		**Elmore**	**1.4%**
Escambia	0.8%		Escambia	0.5%
Etowah	1.8%		Etowah	1.5%
Fayette	0.3%		Fayette	0.1%
Franklin	1.0%		Franklin	0.9%
Geneva	0.3%		Geneva	0.3%

TABLE 2 Continued				
County	**2005 Allocation**		**County**	**2035 Allocation**
Greene	0.1%		Greene	0.1%
Hale	0.3%		Hale	0.3%
Henry	0.5%		Henry	0.2%
Houston	2.0%		Houston	2.3%
Jackson	1.5%		Jackson	1.2%
Jefferson	14.6%		Jefferson	12.6%
Lamar	0.4%		Lamar	0.3%
Lauderdale	1.3%		Lauderdale	1.1%
Lawrence	0.9%		Lawrence	0.7%
Lee	2.3%		Lee	2.5%
Limestone	**1.8%**		**Limestone**	**2.2%**
Lowndes	0.4%		Lowndes	0.5%
Macon	0.2%		Macon	0.1%
Madison	**8.4%**		**Madison**	**12.6%**
Marengo	0.6%		Marengo	0.4%
Marion	0.7%		Marion	0.6%
Marshall	2.4%		Marshall	2.5%
Mobile*	8.3%		Mobile	7.5%
Monroe	1.0%		Monroe	0.7%
Montgomery	4.7%		Montgomery	4.8%
Morgan	**4.2%**		**Morgan**	**4.7%**
Perry	0.2%		Perry	0.1%
Pickens	0.3%		Pickens	0.2%
Pike	0.6%		Pike	0.5%
Randolph	0.3%		Randolph	0.2%
Russell	0.6%		Russell	0.4%
Shelby	**3.4%**		**Shelby**	**4.8%**
St Clair	1.2%		St Clair	1.6%
Sumter	0.1%		Sumter	0.1%
Talladega	1.8%		Talladega	1.6%
Tallapoosa	0.8%		Tallapoosa	0.4%
Tuscaloosa	**6.3%**		**Tuscaloosa**	**6.9%**
Walker	0.9%		Walker	0.7%
Washington	0.6%		Washington	0.8%
Wilcox	0.3%		Wilcox	0.2%
Winston	0.7%		Winston	0.5%

* The projected share for Mobile County does not include freight from the Port of Mobile

Economic Database Update Schedule

The sub-state economic database requires updating so that the most current information can be used to allocate freight traffic. The state's economic circumstances can change because of national, international, and local events and these changes can have long term consequences for freight movement patterns. Most of the data required by the economic database is publicly available and published by federal or state agencies. Some are published quarterly, annually, or with a lag of five years. The update schedule for the Alabama substate economic database is provided in Table 3.

TABLE 3 Database Update Schedule

Data Items	Frequency	Next Update	Source
County Baseline Data			
Manufacturing	5 years	2009	US Census of Manufacturing
Agriculture	5 years	2009	US Census of Agriculture
Logging	5 years	2009	Alabama Forestry Commission
Mining	5 years	2009	US Census of Mining
			US Geological Survey
			County Business Patterns
Growth Projections			
Manufacturing	1 year	2010	Global Insight
Agriculture	1 year	2010	US Dept. of Agriculture
			Economic Research Service
Mining	1 year	2010	US Geological Survey
			US Dept. of Energy
			Energy Information Agency
County Personal Income			
	1 year	2010	US Dept. of Commerce
			Bureau of Economic Analysis

Future Additions to the Economic Database

The present economic database was designed to support just two variables to predict future substate freight traffic distribution – value of sales and personal income. There may be other variables that would give a better fit to actual freight traffic counts on Alabama's major highways. To test which set of variables gives the best fit, new data will be added to the economic database in the future. Some possible additions include the following:

- Employment in heavy industry
- Population by age
- The value of wholesale and retail sales
- Electricity usage
- The tonnage of agricultural products including logs
- The tonnage of extracted mineral products
- Median household income
- State gas tax revenue
- Truck licenses

CONCLUSIONS

This research has shown that local economic data from many different sources can successfully be used to allocate freight volume into smaller FAZ's from the future freight traffic volumes provided by highly aggregated national databases such as FAF2. The output of this effort is used as input to the modeling of freight, and the integration of that freight into existing transportation planning and modeling activities at the state and local level. This has been accomplished in Alabama at the statewide and metropolitan planning organization level, resulting in validated transportation models that integrate freight into the planning activity.

The methodology described in this paper can easily be replicated by other states and metropolitan planning organizations. Future research will be aimed at finding the set of economic variables that best predicts present freight movements into and out of these FAZ's and consequently will be most likely to accurately predict future freight movements.

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