

Report #5 (R5)

Methodology for FAF Regionalization of Out-of-Scope Truck Commodity Flows

1. Introduction

The Freight Analysis Framework (FAF) program is developing a consistent base year 2002 set of inter-regional commodity flows. The FAF three-dimensional matrix (by commodity, region, and transportation mode) of freight flows establishes a primary base for the analysis of all freight shipments. The core component of the FAF is the Commodity Flow Survey (CFS) supplemented by other data sources. CFS, however, does not include traffic flows originating for several “Out-of-Scope” business sectors. Specifically, truck traffic for Farm based, Fisheries, Logging, Construction, Services, Publishing, Retail and Household and Business Moves, totaling 263 trillion ton miles (Table 1) were not sampled. National freight flows for these out-of-scope businesses, which were estimated as part of the FAF program are shown in Table 1. This paper presents an approach to develop FAF region-to- FAF region commodity flows consistent with the national estimates.

Table 1. National Estimate of Truck Shipments of Out-of-Scope Economic Activities				
	Value (\$ millions)	Tons (thousands)	Ton Miles (millions)	Average shipping distance (miles)
Farm based	200,646	1,051,285	40,222	38.26
Fisheries	3,181	4,714	259	54.94
Logging	7,871	350,191	16,271	46.46
Construction	924,974	591,449	62,003	104.83
Services	284,601	277,413	30,500	109.94
Publishing	98,657	32,330	13,945	431.33
Retail	1,408,236	1,050,277	94,411	89.89
Household and Business Moves	12,739	21,204	5,563	262.36
Total	2,940,905	3,378,863	263,174	142
Source: “Out-of-Scope” reports developed for FAF by Macrosys and ORNL.				

In order to generate an expedient and reasonable regionalization of out-of scope commodity flows, one needs to reflect the relative regional differences in economic activity that generate the truck commodity flows using readily and openly available data on state and local economic activity. The regionalization of national truck freight flows followed here is a three step process defining, (1) the allocation of the national freight estimates to the county in which the freight generation occurs, (2) the estimation of county-to-county freight flows for each commodity shipped in the out-of scope business sectors, and (3) then the aggregation of the county-to-county flows to regional commodity flows used in the FAF matrix.

This paper outlines the approach used for the regionalization to FAF regions of national estimates of out-of-scope commodity flows by first generating county-to-county information. Two features of the FAF region-to-region spatial context indicate a county-to-county analysis as a necessary intermediate step in developing the FAF region commodity flows. First the freight analysis flows to be regionalized appear to be relatively short local hauls with an average distance of under 100 miles. Key flows of interest are the FAF-to-FAF region flows, which include urban areas flows to the rest-of-state (regions). However, there are many instances where several urban areas interact with the same “rest-of-state” area, in which the region-to-region distance are defined by the centroid of a relatively large rest of state region. To estimate the interregional flows of such local movements, it is useful to have more spatial discrimination, as in a county-to-county matrix to capture the movements within and around the urban metroplex represented by the short haul out-of-scope activities. The county-to-county flows can then be aggregated to the desired FAF regional scale.

2. Procedure

2.1 Regional Economic Freight Generation

The national estimates are allocated to the county based on local traffic generating activity, but taking into account State variations in truck usage by the business sector as identified in the Vehicle Inventory and Use Survey (VIUS). The VIUS provide annual freight truck miles generated by major business sectors in each State as well as providing commodity (two-digit SCTG code) totals for the state for the year 2002. The approach is to allocate the national total of out-of-scope freight by each commodity and business to the states based on the states share of national activity as depicted in VIUS. The estimate for each state is then allocated to the counties within the state based on an appropriate measure of the economic activity that generates the freight activity. The county weight will typically be based on the 2002 County Business Patterns. This two-step process can be implemented as a single allocation using a set of allocations coefficients (i.e., a nation to state and a state to county coefficients). For a specific commodity carried by an out-of scope business sector the allocation can be represented as:

Equation 1:

$$\begin{aligned} \text{Truck Tonnage Originating in County I for the business sector} = & \\ & (\text{State's share of national truck miles for the business sector}) \times \\ & (\text{County's share of state's earnings for the business sector}) \times \\ & (\text{National tonnage estimate for the business sector}) \end{aligned}$$

Depending on the state and county data available for allocation four different strategies are considered. The first strategy (focusing on the business sector) used for the Construction, Services and Retail trade sectors, uses the business sector information on truck freight mileage from VIUS. Although in each business sector a variety of commodities are shipped and need to be regionalized, the freight generation activity and market area in which the freight movements take place is similar and thus the same allocation strategy would be reasonable to regionalize each commodity carried by the business sector. Thus the same share coefficient will be used for all commodities carried by a specific business for this first strategy. The coefficient is the truck mileage carried by the business sector in the state as compared to the national total. In this strategy the state estimate is then allocated to the counties in the state using an allocation weight reflecting the business sectors local activity as reflected by employment or earnings in the County Business Patterns employment or earnings. (The candidate allocation-variables for this case, "VIUS Sector" is presented in the first set of rows of Table 2.)

The second strategy focuses on commodity characterization for the three farmed-based commodities and logging. In these situations the commodity mix of the appropriate aggregate business sector may vary considerably from state to state and a more refined focus is required. For both the farmed based activities and logging, additional information in VIUS on commodities carried within each state can be used to assist in the regionalization rather than the more aggregate business sector information. In addition county commodity production data (Census of Agriculture and county round wood production from the National Forest Service) is available to better characterize the sub-state regionalization as well. The candidate variables for the regionalization of this set of sectors, "VIUS commodities" is presented in Table 2.

The third strategy involves Fisheries and Printing both of which are special cases. Fisheries are part of the farm based business sector and Live Fish as a commodity is part of the SCTG 01 (Live animals and live fish). Both the sector and the commodity are a small part of the total, and the importance in the sector may vary greatly from one state to another. Consequently, it seems more reasonable to develop a set of allocation variable that are more tightly related to the regional level of activity in the sector. The case for printing is similar in that the appropriate sector (information) is too broad to capture the nature of the printed material considered in the truck shipments. Moreover, the data coverage on State level truck shipments of the commodity printed materials in VIUS is very limited (less than 20% - Table 5). In this case the County Business Patterns (CBP) information on employment or earnings appears as a reasonable proxy for both the state and county level regionalization. The candidate variable for regionalization of this set of sectors (Other) is presented in the third set of Table 2.

A fourth strategy focuses on the Household and Business sector. It uses Census information on county-to-county migration during the period 1990 to 2000 to identify relative regional growth and decline upon which to allocate the national flows.

Type of Allocation	Business Sector	Commodity	State Allocation	State to County Allocation
1 VIUS Sector	Construction	All	VIUS Sector Activity	CBP Sector Employment
	Services	All	VIUS Sector Activity	CBP Sector Employment
	Retail	All	VIUS Sector Activity	CBP Sector Employment
2. VIUS Commodity	Farm Based	Animals	VIUS Commodity	Value in Farm Sales (USDA)
	Farm Based	Cereal	VIUS Commodity	Value in Farm Sales (USDA)
	Farm Based	Other Agriculture	VIUS Commodity	Value in Farm Sales (USDA)
	Logging	Logs and Other Wood	VIUS Commodity	Round Wood Production (NFS)
3. Other	Printing	Printed Materials	CBP Industry Employment	CBP Industry Employment
	Fisheries	Live Fish	CBP Industry Employment	CBP Industry Employment
	Household moves		none	County-to-county migration

Inspection of the VIUS data, however, indicates that some data manipulation will be required to develop the required allocation coefficients.

For the first set of allocation—the VIUS Business Sectors—some missing values for individual states needed to be estimated. Table 3 provides the VIUS data on truck-miles by business sector. Initially, it was proposed to estimate values for the missing state entries for a specific business sector by allocating the residual for that business sector (i.e., the U.S. total minus the sum of the available data) to the states with missing elements in proportion to the state share of all activity for the states considered with missing values. However, after review of the data it was clear that the state totals are not necessarily the sum of the elements. As an alternative, the sector share of the national amount of truck miles was applied to the state total to estimate any of the missing values.

Although this was not a large effort for the three sectors listed in Table 3, developing the service sector series was a bit more complex as not only do missing values need to be estimated but several VIUS business sectors need to be combined into a service sector total as used in the out-of-scope activities. The available state level VIUS data for the service sector components is presented in Table 4.

Table 3. State Truck-Miles by Selected Business Sectors: 2002

State	Total	Agriculture	Construction	Retail Trade
United States	1,114,728.00	20,024.80	75,906.20	27,470.50
Alabama	24,606.7	857.7	800.5	884.7
Alaska	2,542.20	s	115.90	53.80
Arkansas	13,176.50	538.60	1,096.30	405.40
Arizona	20,204.80	49.40	1,531.70	582.40
California	111,971.90	1,692.20	9,295.30	1,854.00
Colorado	19,748.70	251.80	2,238.50	510.90
Connecticut	9,568.30	46.20	744.50	197.30
District of Columbia	462.20	0.40	18.80	0.80
Delaware	2,921.70	56.10	174.30	132.60
Florida	56,606.30	795.20	5,248.50	1,389.40
Georgia	34,019.50	603.70	2,377.80	483.30
Hawaii	3,467.90	67.00	266.80	S 85.46
Iowa	12,347.10	1,030.30	661.70	266.90
Idaho	8,071.90	765.70	662.30	270.90
Illinois	48,603.40	833.90	29,969.20	1,207.00
Indiana	29,211.80	452.60	1,267.20	620.00
Kansas	13,236.60	711.60	698.70	830.90
Kentucky	15,783.00	223.70	1,110.40	320.10
Louisiana	18,442.50	653.00	1,003.30	251.00
Massachusetts	20,161.50	214.90	1,910.40	519.50
Maryland	16,809.80	94.90	1,410.00	110.30
Maine	4,645.70	196.10	303.90	168.90
Michigan	51,806.90	635.10	4,111.10	634.00
Minnesota	23,058.70	681.00	2,212.60	415.00
Missouri	24,254.50	1,152.90	1,658.70	415.90
Mississippi	9,274.60	274.50	537.40	244.50
Montana	4,465.60	286.90	302.60	143.30
North Carolina	34,990.80	745.50	2,978.30	1,085.50
North Dakota	4,743.50	552.40	346.70	124.10
Nebraska	9,693.10	646.20	604.10	192.20
New Hampshire	4,908.90	55.60	243.50	107.70
New Jersey	27,655.00	122.40	1,576.70	452.20
New Mexico	9,202.70	175.10	735.20	332.40
Nevada	7,198.00	s	436.00	180.60
New York	42,093.20	402.00	1,909.50	1,084.00
Ohio	45,649.00	645.70	3,259.40	607.40
Oklahoma	35,154.40	1,167.30	826.70	3,401.40
Oregon	15,749.30	475.70	777.30	353.20
Pennsylvania	34,345.90	336.90	2,425.50	1,109.70
Rhode Island	2,701.50	16.00	164.40	53.20
South Carolina	16,950.30	450.70	1,114.20	506.60
South Dakota	4,246.40	371.70	236.80	215.80
Tennessee	29,436.90	452.00	2,243.40	309.10
Texas	96,175.80	1,958.60	5,107.90	1,984.00

Utah	10,066.10	188.90	480.00	352.50
Virginia	24,983.70	332.30	1,996.40	315.30
Vermont	3,270.40	69.30	267.50	116.00
Washington	20,023.70	589.50	1,054.00	545.00
Wisconsin	25,558.20	848.90	1,896.30	876.20
West Virginia	7,609.70	118.30	326.20	128.90
Wyoming	2,927.80	204.40	170.60	55.80

Key: s= estimate does not meet publication standards because of high sampling variability or poor response quality.

Table 4. State Truck-mile by Components of the Service Sector: 2002

State	Total all business Sectors	Information	Waste, Management	Arts	Accommodations	Other services	Total all services
United States	1,114,728.00	5,622.00	10,709.30	1,784.10	5,816.30	35,776.20	59,707.90
Alabama	24606.7	s	124.0	s	172.1	832.8	
Alaska	2,542.20	s	s	s	s	42.00	
Arkansas	13,176.50	s	182.00		s	529.40	
Arizona	20,204.80	s	178.30	8.20	s	967.40	
California	111,971.90	s	1,427.50	s	144.70	3,265.50	
Colorado	19,748.70		110.40	s	s	489.10	
Connecticut	9,568.30	s	113.20	s	22.50	446.70	
District of Columbia	462.20	7.80	s	8.70	s	36.10	
Delaware	2,921.70	s	29.40	s	24.60	107.00	
Florida	56,606.30	s	854.00	9.20	527.80	1,982.50	
Georgia	34,019.50	s	511.60	s	50.30	908.30	
Hawaii	3,467.90	s	s	s	s	122.20	
Iowa	12,347.10	s	76.90	s	33.60	519.90	
Idaho	8,071.90	s	41.80	5.50	40.60	458.50	
Illinois	48,603.40	s	236.90	s	123.20	1,734.60	
Indiana	29,211.80	s	337.40	s	42.70	436.70	
Kansas	13,236.60	s	61.90	s	38.50	429.40	
Kentucky	15,783.00	s	73.40	s	s	505.50	
Louisiana	18,442.50	s	68.70	s	s	s	
Massachusetts	20,161.50	s	321.10	6.50	84.10	1,106.50	
Maryland	16,809.80	159.30	149.00	3.70	68.10	666.40	
Maine	4,645.70	s	54.30	s	s	252.80	
Michigan	51,806.90	13.50	267.10	s	44.90	1,698.70	
Minnesota	23,058.70	s	s	s	s	445.40	
Missouri	24,254.50	s	152.80	s	s	1,073.70	
Mississippi	9,274.60	8.00	15.40	s	14.80	62.70	
Montana	4,465.60	s	14.30	s	s	130.90	
North Carolina	34,990.80	s	390.60	s	s	1,111.00	
North Dakota	4,743.50	s	38.20	s	9.40	55.60	
Nebraska	9,693.10	s	65.40	s	54.40	110.90	
New Hampshire	4,908.90	1.60	61.10	s	5.30	139.90	
New Jersey	27,655.00	128.00	461.70	s	s	534.10	
New Mexico	9,202.70	s	20.40	s	s	338.10	
Nevada	7,198.00	s	s	s	8.00	363.00	
New York	42,093.20	s	497.20	s	s	1,437.80	
Ohio	45,649.00	s	297.50	s	s	902.50	
Oklahoma	35,154.40	s	224.40	s	461.80	891.10	
Oregon	15,749.30	s	s	s	s	531.00	
Pennsylvania	34,345.90	s	429.70	s	s	665.20	
Rhode Island	2,701.50	s	40.40	s	s	82.40	
South Carolina	16,950.30	5.10	109.10	s	s	556.00	
South Dakota	4,246.40	s	19.90	s	7.70	144.80	
Tennessee	29,436.90	s	641.10	s	63.00	1,416.10	
Texas	96,175.80	s	s	s	846.40	4,611.10	

Utah	10,066.10	s	19.10	s	67.10	214.00
Virginia	24,983.70	s	364.50	s	s	996.70
Vermont	3,270.40	s	47.90	0.80	35.30	55.60
Washington	20,023.70	s	107.50	s	s	372.20
Wisconsin	25,558.20	s	220.00	s	47.00	638.80
West Virginia	7,609.70	7.80	56.40	s	10.00	132.20
Wyoming	2,927.80	s	5.30	s	s	37.70

Key: s=Estimate does not meet publication standards because of high sampling variability or poor response quality.
Source: VIUS

The data for the state allocations by commodity carried as presented in VIUS also has estimated values for missing values in order to provide state share coefficients. The same procedure of applying the national sector share to the state total to estimate the missing values was used here as well.

Table 5. Commodity Shipments in Each State

	<u>Farm Based</u>			<u>Logging</u>	<u>Publishing</u>
	01 <u>animals</u>	02 <u>cereal</u>	03 other <u>agriculture</u>	25 <u>logs</u>	29 <u>printed</u>
United States	2,446.10	1,789.50	4,094.50	1,649.20	3,680.60
Alabama	16.9	14.8	74.6	105.5	85.5
Alaska	s	s	2.00	1.60	s
Arkansas	27.60	16.10	51.30	3.50	s
Arizona	s	1.60	30.80	s	s
California	s	44.00	321.20	129.30	s
Colorado	s	6.00	30.80	5.90	s
Connecticut	s	s	21.20	s	s
District of Columbia	v	v	s	s	s
Delaware	5.20	3.50	s	2.30	1.20
Florida	s	s	172.10	44.80	s
Georgia	s	s	47.60	s	s
Hawaii	0.70	0.10	19.20	0.30	s
Iowa	50.50	108.30	46.10	s	s
Idaho	73.60	83.30	116.80	40.80	s
Illinois	s	128.10	102.60	20.30	127.80
Indiana	25.20	56.80	137.40	19.10	s
Kansas	82.60	107.80	50.00	4.80	s
Kentucky	21.40	18.70	20.60	32.90	s
Louisiana	s	11.00	25.50	50.00	s
Massachusetts	s	s	s	10.40	50.90
Maryland	5.70	3.00	74.80	s	10.60
Maine	s	1.00	s	23.50	s
Michigan	s	s	s	s	s
Minnesota	s	95.50	85.80	50.50	147.60
Missouri	s	87.90	177.50	17.70	26.90
Mississippi	s	17.90	s	29.80	0.50
Montana	24.30	19.20	4.40	13.00	s
North Carolina	46.20	20.50	179.80	89.40	22.90
North Dakota	11.20	89.40	45.00	s	45.40
Nebraska	155.80	166.60	99.50	s	s
New Hampshire	0.60	s	s	9.10	1.80
New Jersey	s	s	151.10	14.50	s

New Mexico	s	9.70	6.30	2.70	s
Nevada	s	1.40	s	0.40	s
New York	s	8.70	163.10	44.80	17.20
Ohio	s	s	143.70	49.80	128.40
Oklahoma	211.00	170.40	366.80	30.70	84.10
Oregon	s	14.20	40.60	15.10	s
Pennsylvania	s	6.30	49.50	s	s
Rhode Island	1.50	s	11.00	1.10	s
South Carolina	s	19.60	45.40	45.00	s
South Dakota	52.30	57.60	30.00	6.00	s
Tennessee	s	s	52.50	31.40	s
Texas	43.70	49.20	227.10	s	22.10
Utah	63.40	16.20	55.30	9.00	10.20
Virginia	9.10	10.00	72.20	42.80	s
Vermont	0.80	2.80	s	14.70	s
Washington	5.70	18.80	s	54.80	s
Wisconsin	92.20	58.90	91.70	76.50	s
West Virginia	12.70	s	s	39.30	7.00
Wyoming	21.90	4.60	14.20	5.20	s
% National Total Value Assigned to States	43%	86%	83%	66%	20%

Key: v=represents an estimate of less than 50 vehicles, 50,000 miles, or 0.05%; s=estimate does not meet publication standards because of high sampling variability or poor response quality.

After filling the missing values as described above, a set of state level share coefficients were developed from the VIUS (and other) data sources. Using the 2002 County Business Patterns (CBP) state and county data, a data set of county market share coefficients were then developed. In the case of missing values for the CBP data, the facility size distribution in the CBP data was used to estimate missing values adequately for the current tasks. With the national estimates, the state and county allocation coefficients organized in a Standard Query Language (SQL) format (using Microsoft Visual FoxPro) it is a simple matter to generate (estimate) a table of freight truck flows for each county, business sector and commodity combination of interest.

2.2 Estimation of Local Market Commodity Flows

The second step is to expand the freight generation at county origin to the destination flow. As discussed in the introduction, the out-of-scope truck traffic examined here, appear to reflect short haul movements that are likely to remain within the local market area. With this view, we defined a reasonable market area for each origin, business sector, and commodity and then estimate the Market Potential. We then allocated the total freight to each of the flows in the market in proportion that the flows contribution to the total market potential. As an expedient, we selected a proxy variable that we expect is proportionate to the market metric. Table 6 augments Table 2, by adding a candidate economic activity variable for each of the Business Sectors in the Out-of-Scope activities to be allocated to local commodity flows.

Type of Allocation	Business Sector	Commodity	State Allocation	State to County Allocation	Market Potential
1 VIUS Sector	Construction	All	VIUS Sector Activity	CBP Sector Employment	CBP Sector Employment
	Services	All	VIUS Sector Activity	CBP Sector Employment	CBP Sector Employment
	Retail	All	VIUS Sector Activity	CBP Sector Employment	Population
2.VIUS Commodity	Farm Based	Animals	VIUS Commodity	Value in Farm Sales (USDA)	CBP Animal Slaughtering and processing Employment
	Farm Based	Cereal	VIUS Commodity	Value in Farm Sales (USDA)	CBP Grain and Oil Seed milling Employment
	Farm Based	Other Agriculture	VIUS Commodity	Value in Farm Sales (USDA)	CBP Food Manufacturing Employment
	Logging	Logs and Other Wood	VIUS Commodity	Round Wood Production (NFS)	CBP Wood Products Employment
3. Other	Printing	Printed Materials	CBP Industry Employment	CBP Industry Employment	Population
	Fisheries	Live Fish	CBP Industry Employment	CBP Industry Employment	CBP Seafood Products Employment

For each origin activity to be allocated, all destinations with 350 hundred miles (over twice the typical average distance – see table 7)¹ -will be considered. The value of each destinations market potential (candidate variable) discounted by a distance (using a specified lambda value) was summed to determine the Total Market Potential for that decay value. Each flow was then allocated a proportionate share of the generated freight based on its contribution to the market potential.

¹ In several instances, such as printed material and household and business moves, the national out-of-scope estimates indicate a more extensive market, and for those cases a larger market radius was considered.

$$\text{Flow}(i,j) = \left(\frac{P(j)/d(i,j)^\lambda}{\sum [P(j)/d(i,j)^\lambda]} \right) \times F(i)$$

Where: $F(i)$ is Freight at origin I to be allocated.
 $P(j)$ is the market potential at destination j
 $[P(j)/d(i,j)^\lambda]$ is the contribution to the total market potential for i derived the interaction with j. (lamda (λ) is the distance decay coefficient for the potential model).
 $\sum [P(j)/d(i,j)^\lambda]$ is the total market potential at i from all potential; destinations.
 $\text{Flow}(i,j)$ is the (allocated) proportionate share of the freight activity assigned between i and j.

The importance of distance (lambda) in the above equation is directly related to the average mile shipped estimation that characterizes the market area. The larger the value of lambda, the more resistance from distance and the smaller the market radius and average distance shipped. It is typical to use a Spatial Interaction Model for determining the lambda and spatial flows consistent with an average distance shipped. The flows are organized as a large matrix and then through iterative computations using various Lambdas, the value that brings about the target average flow is determined. This approach is difficult in the FoxPro environment. As an expedient, a two step procedure was adopted. First a set of lambdas covering the typical range was selected (0.5, 1.0, 1.5, 2.0, 2.5 and 3.0) and market calculations were done for each of the lambda values. Then in the second stage, the results were visually examined and the county flows set whose market potential data generated the average distance that was closest to the target national values for that business sector was chosen as the appropriate lambda value for that business sector. The sector lambda was then used to select the associated set of flows for all commodities considered for the business sector.

As the general market of interest is for the shipments for the business sector, we tuned to a single lambda for each business sector. The exception was farm based activity, because of the potentially very different regional patterns of market area for the different commodities in the sector. We also used different variables to determine the market areas, where as in the other sectors the same variable was used to determine the market area for all commodities. The target “national” average shipping distance reflected of the FAF National Estimates of the Out-of-Scope Activities as presented in Table 7. Also, one can observe that the shipment distances for the various commodities within any given business sectors are similar, hence reinforcing the choice of one lambda (distance decay) for local markets of each business sector.

Table 7. National Estimates by Sector and Commodity with Average Distance Shipped

Business Sector		Commodities	Value	Tons	Ton miles	Average distance shipped
Farm Based		All Commodities	\$200,646	1,051,285	40,222	38.26
	01	Live animals and live fish	\$105,494	90,929	5,047	55.50
	02	Cereal grains	\$39,958	795,382	28,395	35.70
	03	Other agricultural products	\$55,194	164,974	6,780	41.10
Fisheries	01	Live animals and live fish	3,181	4,717	259	54.91
Logging	25	Logs and other wood in the rough	7,871	350,191	16271	46.46
Construction						
		All Commodities	924,974	591,449	62,003	104.83
	01	Live animals and live fish	\$13	11	1	100.00
	02	Cereal grains	\$2	19	3	175.48
	03	Other agricultural products	\$1,041	1,426	143	100.01
	04	Animal feed and products of animal origin, n.e.c.	\$5	21	2	100.00
	05	Meat, fish, seafood, and their preparations	\$89	35	4	100.00
	07	Other prepared foodstuffs and fats and oils	\$22	30	3	100.00
	08	Alcoholic beverages	\$488	343	34	100.00
	10	Monumental or building stone	\$1,106	5,536	561	101.33
	11	Natural sands	\$251	33,072	3,339	100.96
	12	Gravel and crushed stone	\$797	118,534	12,301	103.77
	13	Nonmetallic minerals n.e.c.	\$679	13,757	1,396	101.51
	14	Metallic ores and concentrates	\$2,727	1,226	123	100.00
	15	Coal	\$40	1,927	193	100.00
	16	Crude Petroleum	\$70	425	42	100.00
	17	Gasoline and aviation turbine fuel	\$79	279	28	100.36
	18	Fuel oils	\$856	3,651	404	110.77
	19	Coal and petroleum products, n.e.c.	\$616	3,158	316	100.17
	20	Basic chemicals	\$22	69	7	100.00
	22	Fertilizers	\$14	78	12	148.79
	23	Chemical products and preparations, n.e.c.	\$3,729	1,914	195	101.80
	24	Plastics and rubber	\$1,108	409	44	107.56
	25	Logs and other wood in the rough	\$683	1,152	121	105.37
	26	Wood products	\$5,734	9,679	1,010	104.34

27	Pulp, newsprint, paper, and paperboard	\$112	101	10	100.00
28	Paper or paperboard articles	\$79	55	6	102.26
29	Printed products	\$942	208	21	100.00
30	Textiles, leather, and articles of textiles or leather	\$419	72	7	100.00
31	Nonmetallic mineral products	\$5,626	59,278	6,317	106.57
32	Base metal in primary or semi-finished forms and in finished basic shapes	\$3,933	4,653	518	111.36
33	Articles of base metal	\$56,413	29,324	3,076	104.9
34	Machinery	\$559,662	91,168	9,918	108.7
35	Electronic and other electrical equipment and components and office equipment	\$4,284	509	61	120.36
36	Motorized and other vehicles (including parts)	\$24,927	5,312	569	107.17
37	Transportation equipment, n.e.c.	\$71,275	15,189	1,626	107.04
38	Precision instruments and apparatus	\$149	97	10	100.00
39	Furniture, mattresses and mattress supports, lamps, lighting fittings, and...	\$3,470	934	98	104.70
40	Miscellaneous manufactured products	\$4,889	1,705	174	101.85
41	Waste and scrap	\$1,632	9,200	975	105.96
—	Commodity unknown	\$166,990	176,891	18,336	103.654
Services					
	All Commodities	284,601	277,412.83	30500.46	109.95
01	Live animals and live fish	\$167	147.69	16.24	109.99
02	Cereal grains	\$61	657.05	5.03	7.65
03	Other agricultural products	\$615	842.54	182.91	217.09
04	Animal feed and products of animal origin, n.e.c.	\$7	32.27	7.68	237.93
05	Meat, fish, seafood, and their preparations	\$14,760	5,907.61	871.39	147.50
06	Milled grain products and preparations, and bakery products	\$4,177	2,854.10	342.04	119.84
07	Other prepared foodstuffs and fats and oils	\$21,101	28,346.02	2958.96	104.39
08	Alcoholic beverages	\$613	430.54	43.05	100.00
09	Tobacco products	\$4,862	141.72	14.17	100.00
10	Monumental or building stone	\$84	421.59	45.18	107.17
11	Natural sands	\$7	881.54	90.17	102.28
12	Gravel and crushed stone	\$9	1,288.70	129.81	100.73
13	Nonmetallic minerals n.e.c.	\$62	1,252.55	134.05	107.02
14	Metallic ores and concentrates	\$8	3.75	0.37	100.00
16	Crude Petroleum	\$1	5.13	0.51	100.00
17	Gasoline and aviation turbine fuel	\$8	28.93	2.89	100.00
18	Fuel oils	\$87	369.44	39.87	107.93

	19	Coal and petroleum products, n.e.c.	\$96	492.07	49.21	100.00
	20	Basic chemicals	\$681	2,095.97	209.60	100.00
	21	Pharmaceutical products	\$3,957	369.61	38.26	103.52
	22	Fertilizers	\$242	1,306.82	131.02	100.26
	23	Chemical products and preparations, n.e.c.	\$2,473	1,269.08	129.65	102.16
	24	Plastics and rubber	\$3,382	1,247.86	204.13	163.58
	25	Logs and other wood in the rough	\$285	481.11	53.31	110.81
	26	Wood products	\$1,175	1,983.60	208.89	105.31
	27	Pulp, newsprint, paper, and paperboard	\$87	79.25	7.93	100.00
	28	Paper or paperboard articles	\$161	110.92	11.09	100.03
	29	Printed products	\$348	76.67	7.67	100.00
	30	Textiles, leather, and articles of textiles or leather	\$14,203	2,425.70	245.60	101.25
	31	Nonmetallic mineral products	\$1,350	14,228.71	1423.37	100.04
	32	Base metal in primary or semifinished forms and in finished basic shapes	\$902	1,067.28	115.08	107.83
	33	Articles of base metal	\$17,858	9,282.82	1239.60	133.54
	34	Machinery	\$56,775	9,248.59	1147.55	124.08
	35	Electronic and other electrical equipment and components and office equipment	\$17,877	2,124.87	293.59	138.17
	36	Motorized and other vehicles (including parts)	\$15,018	3,200.27	428.56	133.91
	37	Transportation equipment, n.e.c.	\$937	199.74	19.97	100.00
	38	Precision instruments and apparatus	\$1,204	785.49	78.55	100.00
	39	Furniture, mattresses and mattress supports, lamps, lighting fittings, and...	\$986	265.39	28.86	108.74
	40	Miscellaneous manufactured products	\$4,584	1,598.80	218.04	136.37
	41	Waste and scrap	\$17,673	99,652.20	10491.96	105.29
	—	Commodity unknown	\$75,720	80,208.87	8834.64	110.15
Publishing	29	Printed Products	\$144,235	36,490	18,277	500.88
Retail		All Commodities	1,408,236.05	1,050,277	94,411	89.89
	01	Live animals and live fish	481.58	398	46	115.14
	03	Other agricultural products	55,941.44	111,985	10,208	91.16
	04	Animal feed and products of animal origin, n.e.c.	13,197.67	57,707	4,737	82.09
	05	Meat, fish, seafood, and their preparations	46,782.20	19,639	1,854	94.39
	06	Milled grain products and preparations, and bakery products	14,359.10	13,844	1,103	79.70
	07	Other prepared foodstuffs and fats and oils	65,298.26	82,444	7,331	88.92
	08	Alcoholic beverages	46,392.26	38,068	3,969	104.27
	09	Tobacco products	41,546.49	2,599	197	76.00
	15	Coal	26.18	1,419	108	76.00

16	Crude Petroleum	20.35	124	10	84.33
18	Fuel oils	5,524.34	26,119	2,146	82.17
19	Coal and petroleum products, n.e.c.	20,164.77	109,988	9,068	82.45
21	Pharmaceutical products	147,763.93	7,485	569	76.00
22	Fertilizers	5,761.95	44,729	3,927	87.78
23	Chemical products and preparations, n.e.c.	45,520.48	21,286	1,663	78.11
24	Plastics and rubber	4,548.23	1,955	193	98.97
26	Wood products	27,309.74	59,574	4,963	83.30
27	Pulp, newsprint, paper, and paperboard	39.05	52	5	100.67
28	Paper or paperboard articles	18,247.81	12,177	1,099	90.23
29	Printed products	14,590.94	3,691	324	87.68
30	Textiles, leather, and articles of textiles or leather	166,140.73	18,249	1,806	98.97
31	Nonmetallic mineral products	4,867.11	31,419	2,667	84.90
32	Base metal in primary or semi-finished forms and in finished basic shapes	1,857.75	2,346	241	102.55
33	Articles of base metal	13,033.24	6,470	610	94.36
34	Machinery	40,649.61	5,322	466	87.51
35	Electronic and other electrical equipment and components and office equipment	117,743.42	6,555	587	89.58
36	Motorized and other vehicles (including parts)	1,539.34	274	27	98.56
38	Precision instruments and apparatus	11,289.93	921	99	107.00
39	Furniture, mattresses and mattress supports, lamps, lighting fittings, and...	42,270.54	9,846	864	87.79
40	Miscellaneous manufactured products	70,784.32	14,472	1,403	96.92
41	Waste and scrap	9,640.80	55,265	4,761	86.15
43	Mixed freight	205,415.23	73,314	7,066	96.38
—	Commodity unknown	149,487.29	210,544	20,293	96.38

Key: n.e.c.=not elsewhere classified.

In most cases, at least one of the computed distance value (i.e., lambda) for each business sector was close to the target value. Table 8 shows the selected distance decay for each of the business sectors. Because the average shipping distance of publishing and household & business moves were considerably larger than the other sectors, it was assumed that these two activities had a national scope as opposed to the local (under 350 miles) use for the rest of the sectors. In the case of publications, we used the same methodology as the other sectors, except that we included all counties thus permitting long distance shipments based on the potential model. Including all counties did stress the software/hardware set we were using, and we could not run the full set of lambda's simultaneously as we did for the other sectors. As an alternative we elected to start with the less restrictive decay and then progress till we matched the target. As seen in the table, we found an approximate match at a lambda of 1.0 and proceeded no further for

this sector. For the household and business moves, it was thought that the simple potential model might not capture some of the significant changes in recent regional growth that might stimulate inter-regional moves. The recent availability of the county-to-county migration flows (Census 2000) between 1990 and 2000 provide a snapshot of such recent changes. The relative county-to-county flows provide an alternative measure to a standard market potential that does reflect changing regional population growth that induces household and business movement of household goods and business equipment. The average distance of this method is approximately 485 miles somewhat higher than the national estimate but given the approximate nature of both the national values and regional allocation not too extreme to reject the approach. As time and effort warrant some alternative analysis of this sector would be of interest.

	National Value	Value of distance decay (λ)					
		0.5	1.0	1.5	2.0	2.5	3.0
Farm based							
01-Live Animals	55.5	166.7	133.4	103.1	76.0	55.7	24.2
02-Cereal & grains	35.7	160.3	129.0	99.9	78.4	63.4	44.0
03-other agr	41.1	150.2	116.6	83.1	57.2	40.5	30.3
Construction	66.69	134.2	99.5	70.1	49.1	35.5	27.3
Retail	41.8	146.2	112.5	80.4	55.6	39.1	29.2
Service	80.6	139.7	106.5	76.9	54.7	39.2	30.2
Fisheries	54.9	111.2	92.3	76.1	64.2	51.6	40.4
Logging	46.4	158.3	127.6	92.8	61.8	40.6	27.6
Publishing ¹	500.9	920	543	-	-	-	-
Household and Business Moves ²	262.36	484.6					

Source: ORNL calculations
Notes: 1. Publishing used all counties and this required sequential runs until target reached.
2. Household and Business moves used market shares generated by migration flows rather than distance decay model.

2.3 Estimation of Local Market Commodity Flows

The step above provides commodity flow tables that have values for each of the key county-to-county freight flow characteristics: business sector, commodity, origin-county (FIPS code), destination-county (FIPS code), distance from origin to destination, tons trucked. Then for each commodity, the national value-to-tons ratio is applied to the allocated freight tons to derive the associated freight value for each of the estimated flows.

As part of the project, ORNL developed a cross walk from the FIPS county codes to the FAF region codes. Using this cross walk the county-to-county flow table is augmented with the appropriate origin FAF Region and the destination FAF Region codes. The resultant file is then aggregated to a “Matrix” table with the FAF commodity flow matrix dimensions: FAF origin, FAF destination, Business Sector, SCTG 2 digit Commodity, Truck Mode. The measures for each FAF-to-FAF truck flow include the Freight tons, Freight Value and the average ton miles for that flow.

This “out-of-scope” truck freight matrix can then easily be integrated into the full FAF Commodity Flow Matrix.

2.4 Data Sources to be Used in the Out-of-Scope Regionalization

1. U. S. Census Bureau, 2002 Economic Census, *Vehicle Inventory and Use Survey* (VIUS), Geographic Area Series, 2004
2. U. S. Census Bureau, 2002 County Business Patterns, Census Bureau
3. U. S. Census Bureau, *2002 Census of Population*, County-to-County Migration Flow Files
4. U. S. Census Bureau, County population and estimated components of population change, all counties: April 1, 2000 to July 1, 2004,
5. U. S. Department of Agriculture, 2002 Census of Agriculture,
6. Bureau of Economic Area, 2002 Regional Economic Information System (REIS), (county population and income).
7. National Forest Service, 2002 Round Wood Production,
8. 2002 National Estimates of Out-of-Scope Freight, Freight Analysis Framework working papers.
9. County-to-county highway distances, ORNL
10. County-to-FAF region cross walk, ORNL