5-4713-01-P3

Manual for the Computation of the Disaggregate County-Level Truck Flows and Explanation of Model Calibration

Authors:
Mark Hodges, P.D.
Jolanda Prozzi
Alejandro Perez-Ordonez

TxDOT Project 5-4713-01: *Implementing a Truck Travel Database*

AUGUST 2006

Performing Organization:	**Sponsoring Organization:**
Center for Transportation Research The University of Texas at Austin 3208 Red River, Suite 200 Austin, Texas 78705-2650	Texas Department of Transportation Research and Technology Implementation Office P.O. Box 5080 Austin, Texas 78763-5080
Project conducted in cooperation with the Federal Highway Administration and the Texas Department of Transportation.	

MANUAL FOR THE COMPUTATION OF DISAGGREGATE COUNTY-LEVEL TRUCK FLOWS AND EXPLANATION OF MODEL CALIBRATION

INTRODUCTION

Truck data is critical to transportation planning in any region. Inter-city and interstate truck flows have an important impact on traffic volumes, the mix of traffic, and experienced level of congestion on the state-maintained infrastructure. In Technical Report 0-4713-R1 entitled *"Development of Sources and Methods for Securing Truck Travel Data in Texas",* a multinomial logit approach was proposed to estimate county level truck travel data from the publicly available 1997 Commodity Flow Survey (CFS) and IMPLAN data over the short term. Although not a required research product, the modeling approach was considered very useful to TxDOT. The objective of this manual is to explain how to use the calibrated multinomial logit (MNL) models to generate disaggregate county-level truck flows for Texas and to present a detailed explanation of the required steps to calibrate the MNL models in the future.

COMPUTATION OF DISAGGREGATE COUNTY-LEVEL TRUCK FLOWS

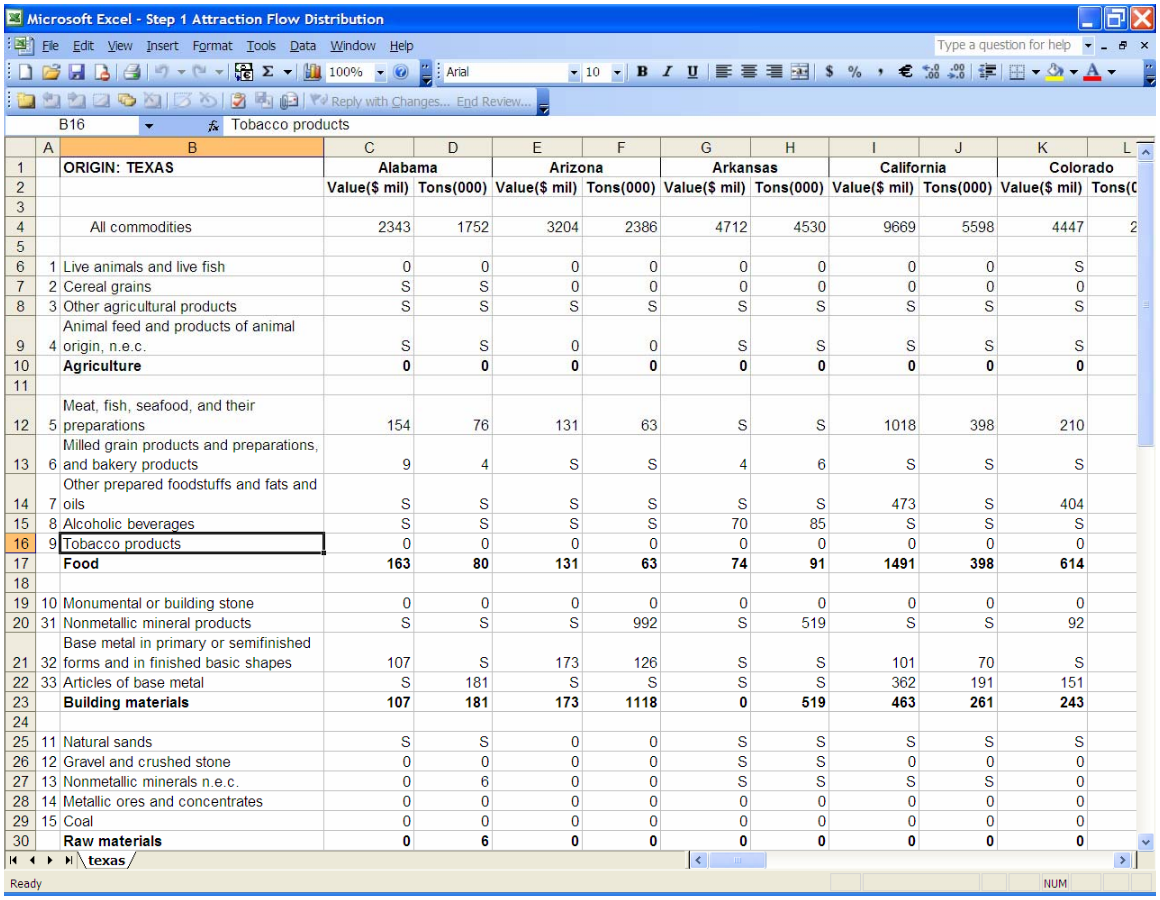
This section of the manual describes the steps involved in applying the calibrated multinomial logit (MNL) models to generate county-level truck flows for Texas in Excel, as well as the required format changes to the Excel workbooks to allow the data to be exported to the Access truck travel database developed as part of this research.

Step 1: Copy and Update the Attraction and Production Distribution Flow Workbooks

Copy the files “Step 1 Attraction Flow Distribution.xls” and “Step 1 Production Flow Distribution.xls” to the computer’s hard drive.

Update both the Attraction and Production Flow Distribution workbooks with the latest Commodity Flow Survey (CFS) information. In the 1997 CFS, this information could be extracted from “StatesTbl15(1997): Shipment characteristics by 2 digit commodity and mode of transportation” and in the 2002 CFS from “Table 17: Shipment Characteristics by Destination State, Two-Digit Commodity and Mode of Transportation of Origin.”

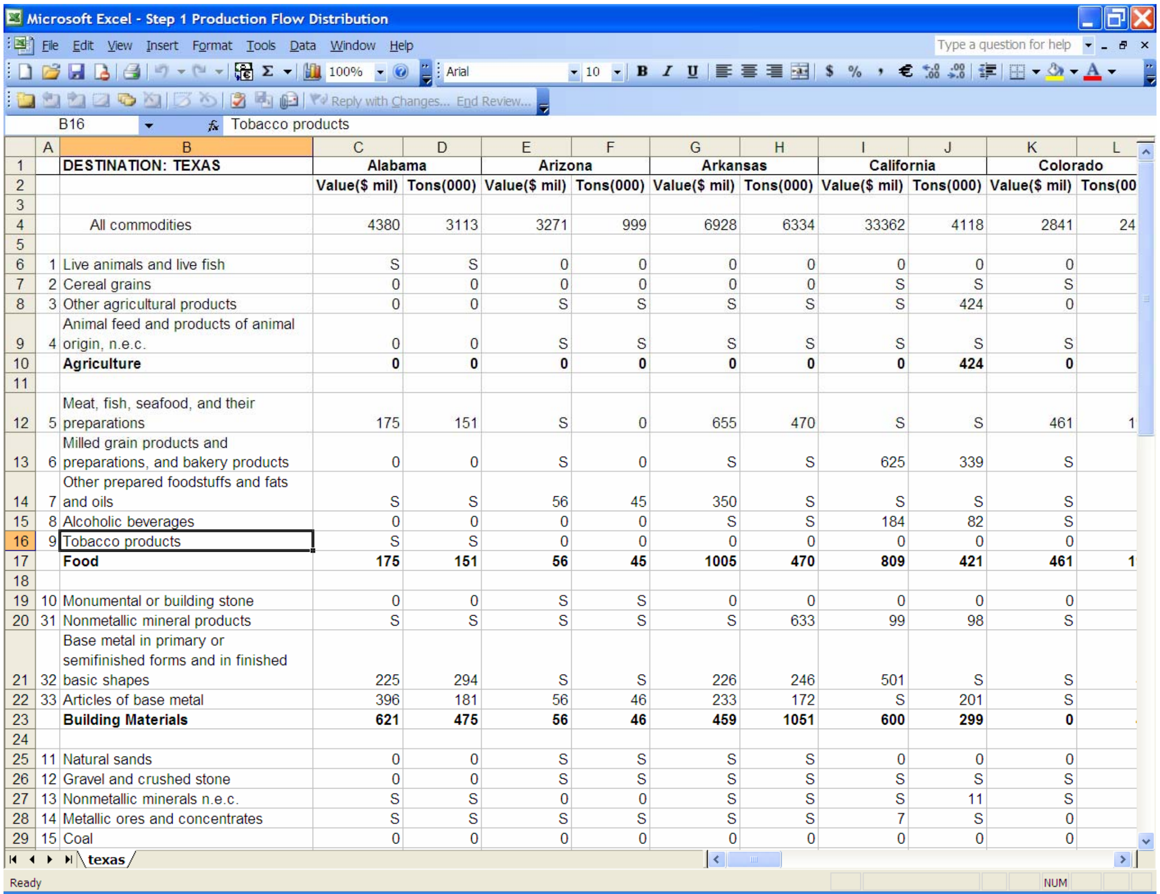
For the Attraction Flow Distribution workbook, the truck tonnage and value by commodity originating in Texas and destined for each state has be to extracted and entered in the Attraction Flow Distribution workbook (see screenshot on opposite page).



	A	B	C	D	E	F	G	H	I	J	K	L
1		**ORIGIN: TEXAS**	**Alabama**		**Arizona**		**Arkansas**		**California**		**Colorado**	
2			**Value($ mil)**	**Tons(000)**	**Value($ mil)**	**Tons(000)**	**Value($ mil)**	**Tons(000)**	**Value($ mil)**	**Tons(000)**	**Value($ mil)**	**Tons(0**
3												
4		All commodities	2343	1752	3204	2386	4712	4530	9669	5598	4447	2
5												
6	1	Live animals and live fish	0	0	0	0	0	0	0	0	S	
7	2	Cereal grains	S	S	0	0	0	0	0	0	0	
8	3	Other agricultural products	S	S	S	S	S	S	S	S	S	
9	4	Animal feed and products of animal origin, n.e.c.	S	S	0	0	S	S	S	S	S	
10		**Agriculture**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
11												
12	5	Meat, fish, seafood, and their preparations	154	76	131	63	S	S	1018	398	210	
13	6	Milled grain products and preparations, and bakery products	9	4	S	S	4	6	S	S	S	
14	7	Other prepared foodstuffs and fats and oils	S	S	S	S	S	S	473	S	404	
15	8	Alcoholic beverages	S	S	S	S	70	85	S	S	S	
16	9	Tobacco products	0	0	0	0	0	0	0	0	0	
17		**Food**	**163**	**80**	**131**	**63**	**74**	**91**	**1491**	**398**	**614**	
18												
19	10	Monumental or building stone	0	0	0	0	0	0	0	0	0	
20	31	Nonmetallic mineral products	S	S	S	992	S	519	S	S	92	
21	32	Base metal in primary or semifinished forms and in finished basic shapes	107	S	173	126	S	S	101	70	S	
22	33	Articles of base metal	S	181	S	S	S	S	362	191	151	
23		**Building materials**	**107**	**181**	**173**	**1118**	**0**	**519**	**463**	**261**	**243**	
24												
25	11	Natural sands	S	S	0	0	S	S	S	S	S	
26	12	Gravel and crushed stone	0	0	0	0	S	S	0	0	0	
27	13	Nonmetallic minerals n.e.c.	0	6	0	0	S	S	S	S	0	
28	14	Metallic ores and concentrates	0	0	0	0	0	0	0	0	0	
29	15	Coal	0	0	0	0	0	0	0	0	0	
30		**Raw materials**	**0**	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	

texas

For the Production Flow Distribution workbook, the truck tonnage and value by commodity destined for Texas originating from each state has be to extracted and entered in the Production Flow Distribution workbook (see screenshot on opposite page).

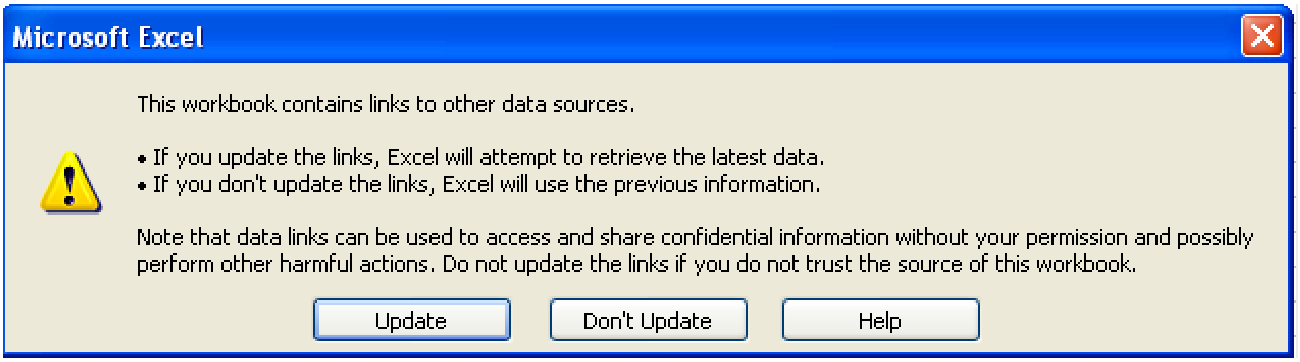


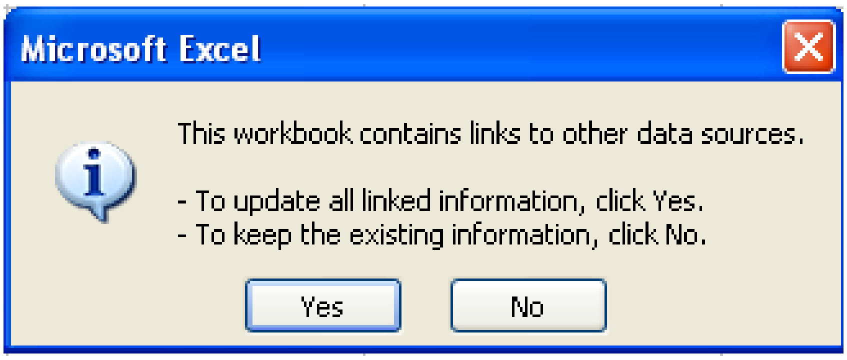
	A	B	C	D	E	F	G	H	I	J	K	L
1		**DESTINATION: TEXAS**	**Alabama**		**Arizona**		**Arkansas**		**California**		**Colorado**	
2			**Value($ mil)**	**Tons(000)**	**Value($ mil)**	**Tons(000)**	**Value($ mil)**	**Tons(000)**	**Value($ mil)**	**Tons(000)**	**Value($ mil)**	**Tons(00**
3												
4		All commodities	4380	3113	3271	999	6928	6334	33362	4118	2841	24
5												
6	1	Live animals and live fish	S	S	0	0	0	0	0	0	0	
7	2	Cereal grains	0	0	0	0	0	0	S	S	S	
8	3	Other agricultural products	0	0	S	S	S	S	S	424	0	
9	4	Animal feed and products of animal origin, n.e.c.	0	0	S	S	S	S	S	S	S	
10		**Agriculture**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**424**	**0**	
11												
12	5	Meat, fish, seafood, and their preparations	175	151	S	0	655	470	S	S	461	1
13	6	Milled grain products and preparations, and bakery products	0	0	S	0	S	S	625	339	S	
14	7	Other prepared foodstuffs and fats and oils	S	S	56	45	350	S	S	S	S	
15	8	Alcoholic beverages	0	0	0	0	S	S	184	82	S	
16	9	Tobacco products	S	S	0	0	0	0	0	0	0	
17		**Food**	**175**	**151**	**56**	**45**	**1005**	**470**	**809**	**421**	**461**	**1**
18												
19	10	Monumental or building stone	0	0	S	S	0	0	0	0	0	
20	31	Nonmetallic mineral products	S	S	S	S	S	633	99	98	S	
21	32	Base metal in primary or semifinished forms and in finished basic shapes	225	294	S	S	226	246	501	S	S	
22	33	Articles of base metal	396	181	56	46	233	172	S	201	S	
23		**Building Materials**	**621**	**475**	**56**	**46**	**459**	**1051**	**600**	**299**	**0**	
24												
25	11	Natural sands	0	0	S	S	S	S	0	0	0	
26	12	Gravel and crushed stone	0	0	S	S	S	S	S	S	S	
27	13	Nonmetallic minerals n.e.c.	S	S	0	0	S	S	S	11	S	
28	14	Metallic ores and concentrates	S	S	S	S	S	S	7	S	0	
29	15	Coal	0	0	0	0	0	0	0	0	0	

Step 2: Copy and Update the Remaining Workbooks

Once the analyst has updated the Attraction and Production Flow Distribution workbooks, the subsequent steps are:

1. Copy the remaining files on the CD to the same folder as the Attraction and Production Flow Distribution workbooks.
2. Open “Step 2 State to Texas County Flows”. A text message will appear similar to those on the opposite page (depending on the Excel version used). Click “Update” or “Yes” depending on the message.
3. Save the file and exit.
4. Open “Texas County to State Flows.xls” and follow sub-steps (1) to (3).
5. Repeat sub-steps (1) to (3) for all the “Intercounty commodity” files also.


Microsoft Excel
This workbook contains links to other data sources.
• If you update the links, Excel will attempt to retrieve the latest data.
• If you don't update the links, Excel will use the previous information.
Note that data links can be used to access and share confidential information without your permission and possibly perform other harmful actions. Do not update the links if you do not trust the source of this workbook.
Update
Don't Update
Help

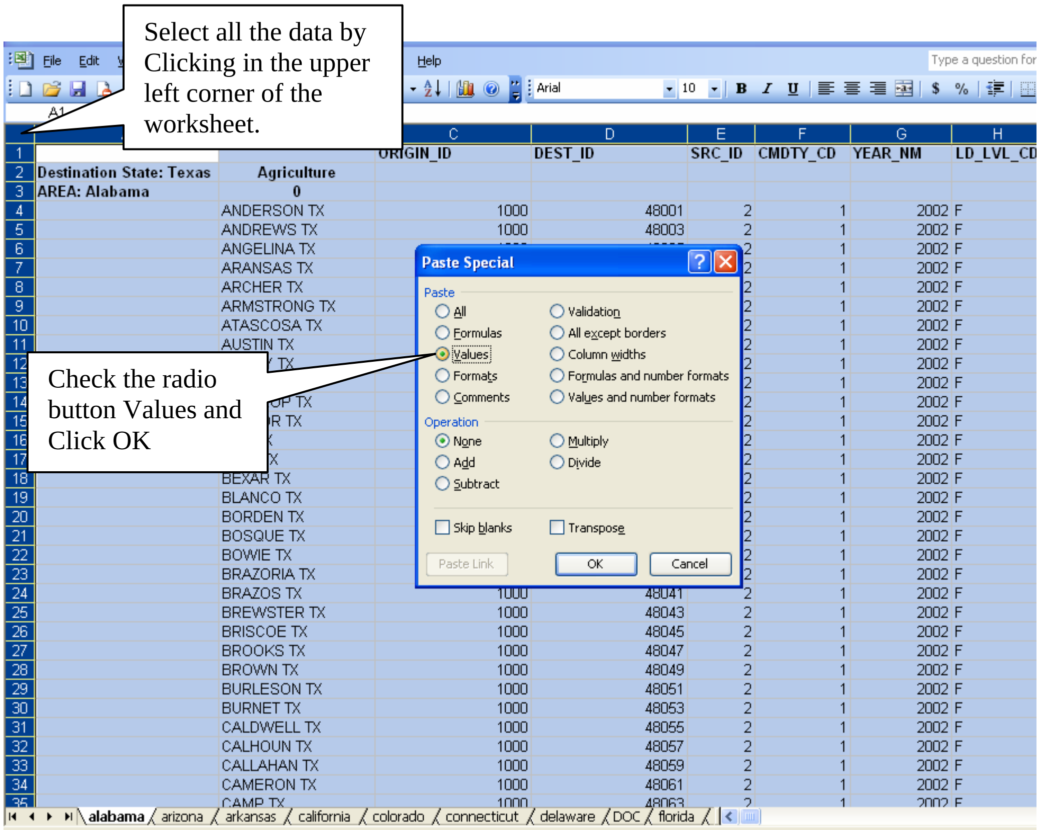

Microsoft Excel
This workbook contains links to other data sources.
- To update all linked information, click Yes.
- To keep the existing information, click No.
Yes
No

Step 3: Export the Truck Travel Data to Access

Once all the tonnage values for State-to-Texas county, Texas county-to-state, and intercounty commodity truck flows have been updated, the truck travel data needs to be exported to the truck travel database developed in Access for use in the Statewide Analysis Model (SAM). The following steps are required to format the Excel workbooks and to import the data into Access.

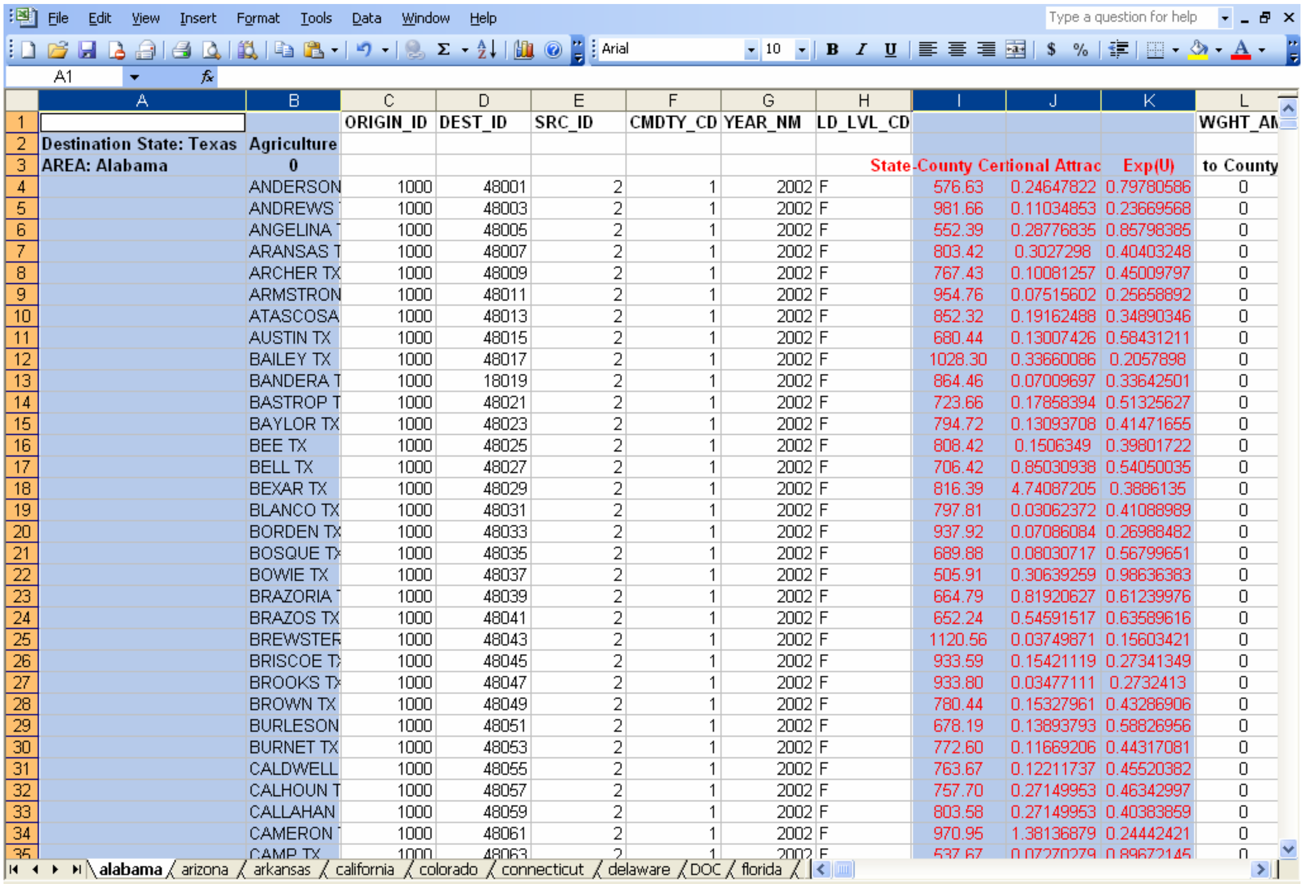
Step 3(a): Format the Excel Workbooks

1. Open "Step 2 State to Texas County Flows.xls". Click "Don't Update" or "No" when asked to update the file again.
2. Select all the data by Clicking in the upper left corner of the worksheet.
3. Copy and Paste Special the data to the same workspace by Clicking Edit – Copy – Edit – Paste Special. Check the radio button Values and Click OK (see screenshot on the opposite page).


Select all the data by Clicking in the upper left corner of the worksheet.
Check the radio button Values and Click OK
Paste Special
Paste
All
Formulas
Values
Formats
Comments
Validation
All except borders
Column widths
Formulas and number formats
Values and number formats
Operation
None
Add
Subtract
Multiply
Divide
Skip blanks
Transpose
Paste Link
OK
Cancel

4. Delete Columns A (labeled Destination State:Texas) and B (labeled Agriculture), and the NEW[1] Columns G (labeled State-County Centroidal Distance), H (labeled Fractional Attraction), and I (labeled Exp(U)). These columns are highlighted with red font (see screenshot on the opposite page).

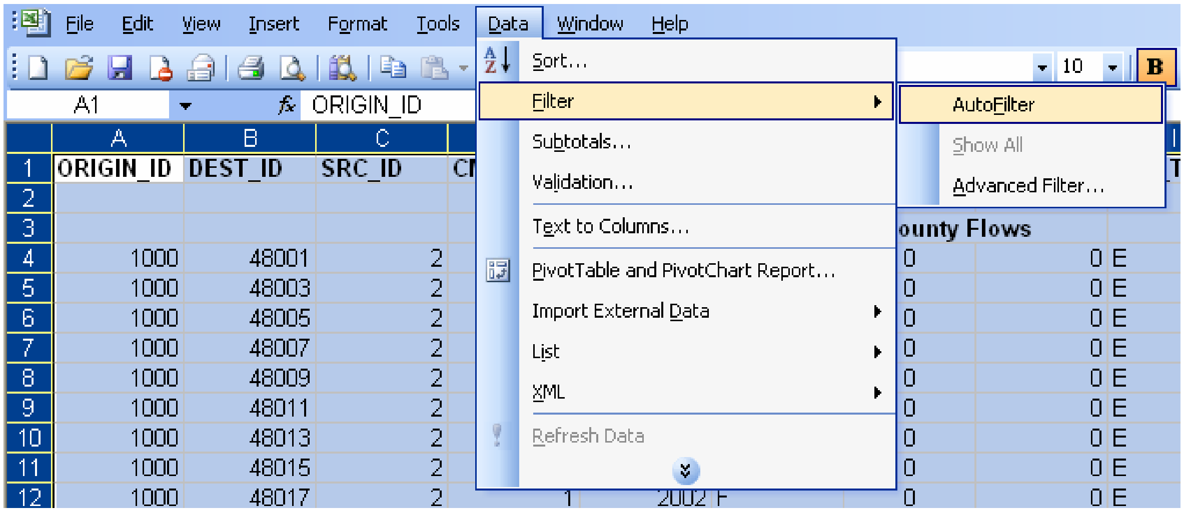
[1] Columns G, H, and I after Columns A and B have been deleted.

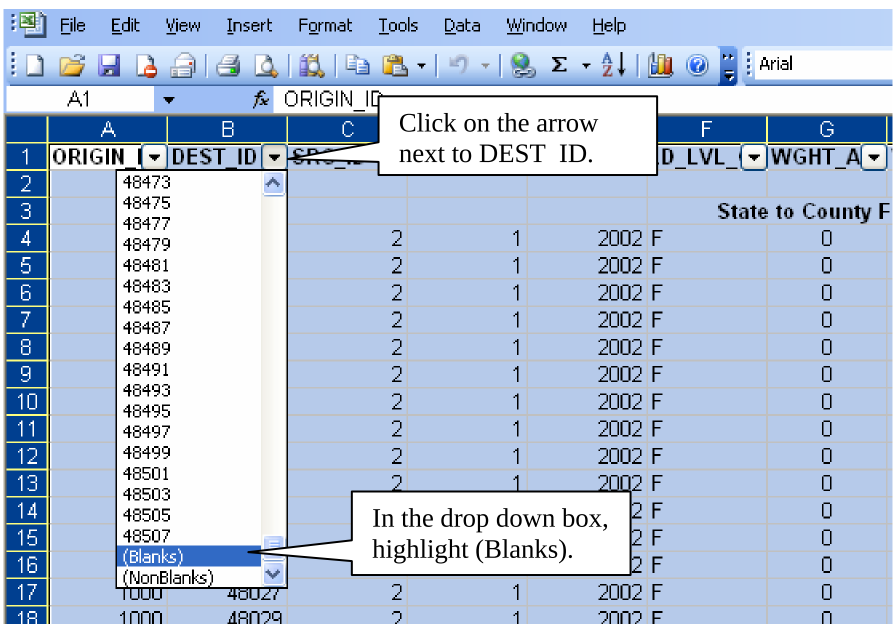


	A	B	C	D	E	F	G	H	I	J	K	L
1			ORIGIN_ID	DEST_ID	SRC_ID	CMDTY_CD	YEAR_NM	LD_LVL_CD				WGHT_AM
2	Destination State: Texas	Agriculture										
3	AREA: Alabama	0							State-County Certional Attrac		Exp(U)	to County
4		ANDERSON	1000	48001	2	1	2002	F	576.63	0.24647822	0.79780586	0
5		ANDREWS	1000	48003	2	1	2002	F	981.66	0.11034853	0.23669568	0
6		ANGELINA	1000	48005	2	1	2002	F	552.39	0.28776835	0.85798385	0
7		ARANSAS T	1000	48007	2	1	2002	F	803.42	0.3027298	0.40403248	0
8		ARCHER TX	1000	48009	2	1	2002	F	767.43	0.10081257	0.45009797	0
9		ARMSTRON	1000	48011	2	1	2002	F	954.76	0.07515602	0.25658892	0
10		ATASCOSA	1000	48013	2	1	2002	F	852.32	0.19162488	0.34890346	0
11		AUSTIN TX	1000	48015	2	1	2002	F	680.44	0.13007426	0.58431211	0
12		BAILEY TX	1000	48017	2	1	2002	F	1028.30	0.33660086	0.2057898	0
13		BANDERA T	1000	18019	2	1	2002	F	864.46	0.07009697	0.33642501	0
14		BASTROP T	1000	48021	2	1	2002	F	723.66	0.17858394	0.51325627	0
15		BAYLOR TX	1000	48023	2	1	2002	F	794.72	0.13093708	0.41471655	0
16		BEE TX	1000	48025	2	1	2002	F	808.42	0.1506349	0.39801722	0
17		BELL TX	1000	48027	2	1	2002	F	706.42	0.85030938	0.54050035	0
18		BEXAR TX	1000	48029	2	1	2002	F	816.39	4.74087205	0.3886135	0
19		BLANCO TX	1000	48031	2	1	2002	F	797.81	0.03062372	0.41088989	0
20		BORDEN TX	1000	48033	2	1	2002	F	937.92	0.07086084	0.26988482	0
21		BOSQUE TX	1000	48035	2	1	2002	F	689.88	0.08030717	0.56799651	0
22		BOWIE TX	1000	48037	2	1	2002	F	505.91	0.30639259	0.98636383	0
23		BRAZORIA	1000	48039	2	1	2002	F	664.79	0.81920627	0.61239976	0
24		BRAZOS TX	1000	48041	2	1	2002	F	652.24	0.54591517	0.63589616	0
25		BREWSTER	1000	48043	2	1	2002	F	1120.56	0.03749871	0.15603421	0
26		BRISCOE TX	1000	48045	2	1	2002	F	933.59	0.15421119	0.27341349	0
27		BROOKS TX	1000	48047	2	1	2002	F	933.80	0.03477111	0.2732413	0
28		BROWN TX	1000	48049	2	1	2002	F	780.44	0.15327961	0.43286906	0
29		BURLESON	1000	48051	2	1	2002	F	678.19	0.13893793	0.58826956	0
30		BURNET TX	1000	48053	2	1	2002	F	772.60	0.11669206	0.44317081	0
31		CALDWELL	1000	48055	2	1	2002	F	763.67	0.12211737	0.45520382	0
32		CALHOUN T	1000	48057	2	1	2002	F	757.70	0.27149953	0.46342997	0
33		CALLAHAN	1000	48059	2	1	2002	F	803.58	0.27149953	0.40383859	0
34		CAMERON	1000	48061	2	1	2002	F	970.95	1.38136879	0.24442421	0
35		CAMP TX	1000	48063	2	1	2002	F	537.67	0.07270279	0.89672145	0

alabama / arizona / arkansas / california / colorado / connecticut / delaware / DOC / florida

5. Select all the data again by Clicking in the upper left corner of the worksheet. Then Click Data – Filter - Auto Filter (see screenshot on the opposite page).
6. With all the data still selected, Click on the arrow next to DEST_ID. In the drop down box, highlight (Blanks) (see screenshot on the opposite page).

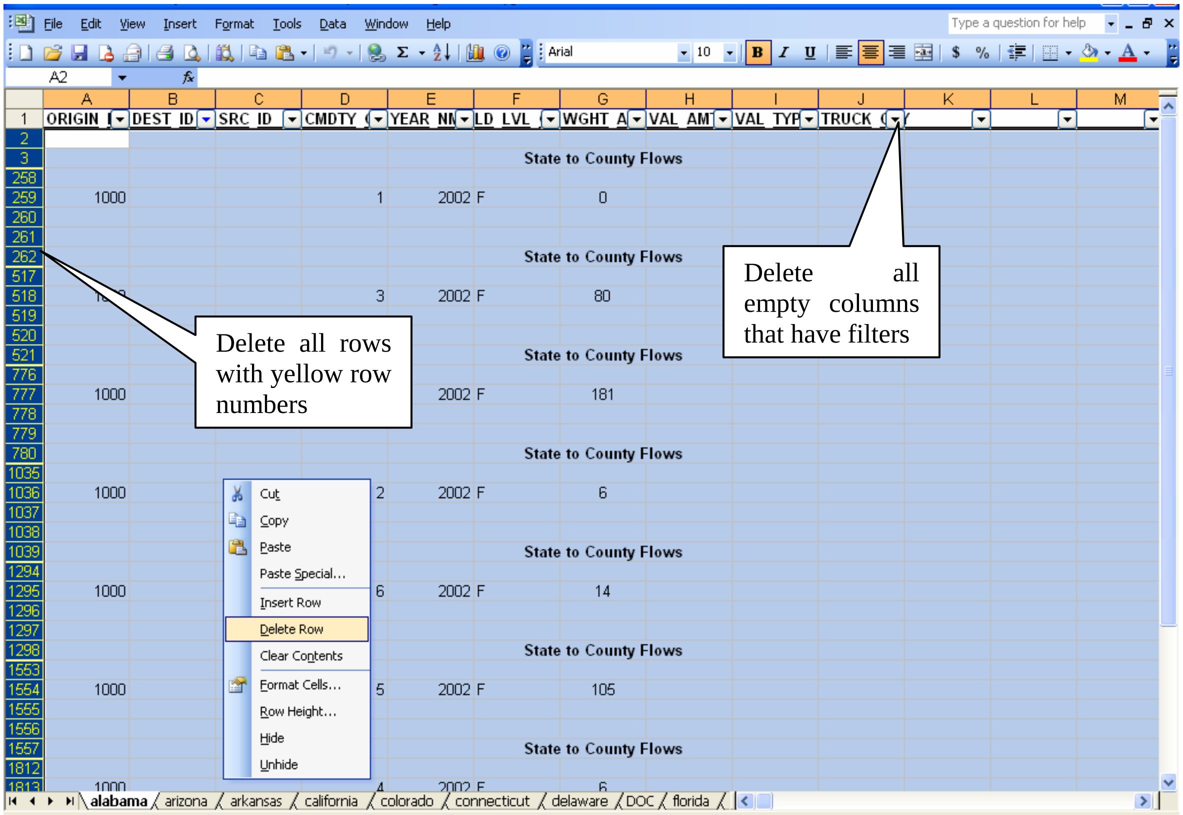

File Edit View Insert Format Tools Data Window Help
A1
ORIGIN_ID
Sort...
Filter
AutoFilter
Show All
Advanced Filter...
Subtotals...
Validation...
Text to Columns...
PivotTable and PivotChart Report...
Import External Data
List
XML
Refresh Data
ORIGIN_ID DEST_ID SRC_ID
ounty Flows

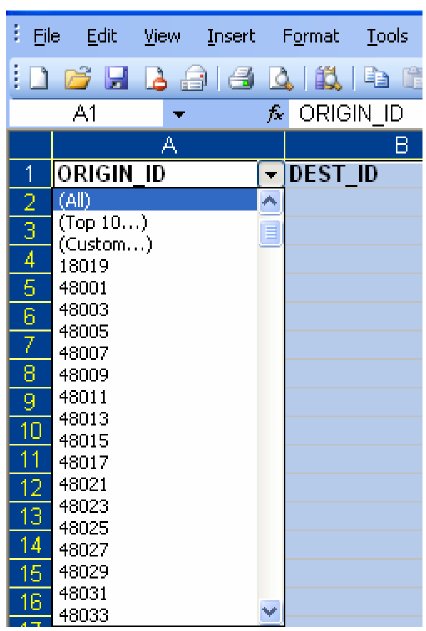

File Edit View Insert Format Tools Data Window Help
Arial
A1
ORIGIN_ID
Click on the arrow next to DEST ID.
ORIGIN_I DEST_ID
D_LVL_ WGHT_A
State to County F
(Blanks)
(NonBlanks)
In the drop down box, highlight (Blanks).

7. Delete all the rows that contain data (i.e., row numbers will be yellow) by Selecting all the rows and Clicking Edit – Delete Row. Also, Delete all empty columns that have filters.
8. Click again on the arrow next to DEST_ID and highlight “All”. Then Click Data – Filter - Auto Filter to exit the filter mode.
9. Repeat these steps for each of the state worksheets.

To format the Step 2 Texas County to State Flows workbook, repeat Steps 1 to 4. For Step 5, select the ORIGIN_ID to filter the “Blanks” instead of the DEST_ID. Repeat the remaining Steps 6 to 9.

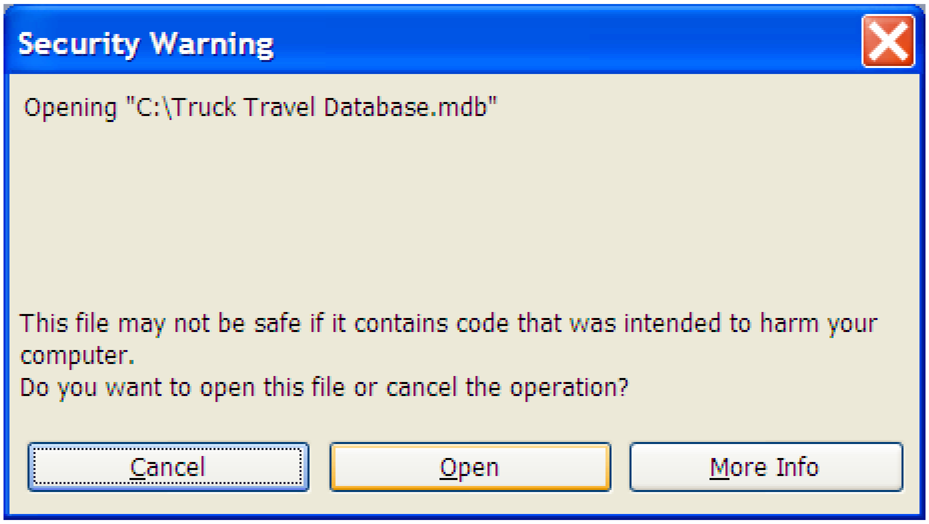
To format the Intercounty “Commodity” workbooks, repeat Step 1 and 2. For Step 3, erase Column A (labeled County), Column B (labeled County to Texas “Commodity”), and Column C (labeled County). Subsequently delete the NEW columns G, (labeled State to County Centroidal Distance), H (labeled Fractional Attractions), and I (labeled Exp(U)). These columns are highlighted in yellow. Repeat the remaining Steps 4 to 9.

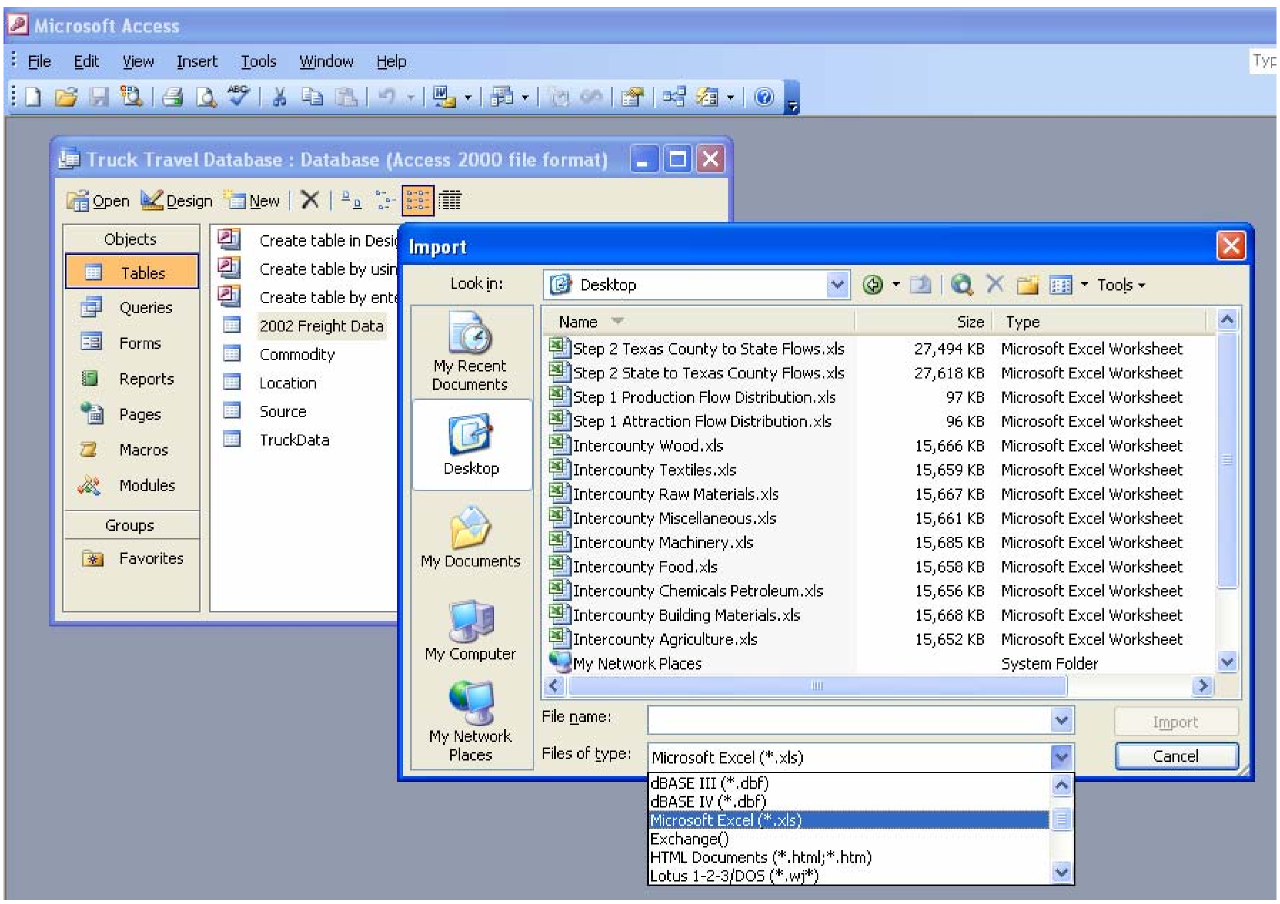

File Edit View Insert Format Tools Data Window Help
Type a question for help
A2
ORIGIN_ID DEST_ID SRC_ID CMDTY YEAR_NM LD_LVL WGHT_A VAL_AMT VAL_TYP TRUCK
State to County Flows
Delete all empty columns that have filters
Delete all rows with yellow row numbers
Cut
Copy
Paste
Paste Special...
Insert Row
Delete Row
Clear Contents
Format Cells...
Row Height...
Hide
Unhide
alabama arizona arkansas california colorado connecticut delaware DOC florida


File Edit View Insert Format Tools
A1
ORIGIN_ID
DEST_ID
(All)
(Top 10...)
(Custom...)
18019
48001
48003
48005
48007
48009
48011
48013
48015
48017
48021
48023
48025
48027
48029
48031
48033

Step 3(b): Import the Truck Travel Data into Access:

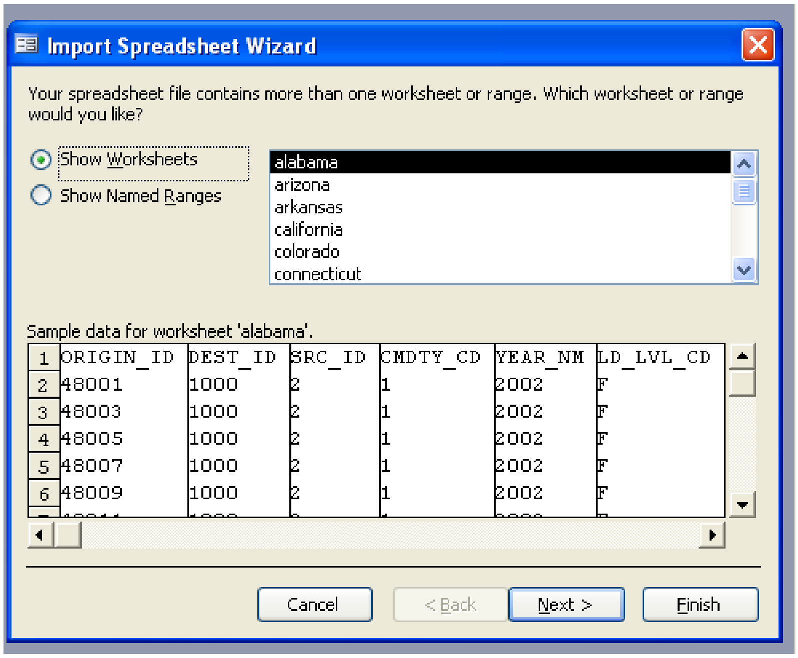
1. Copy the Truck Travel Database (i.e., Truck Travel Database.mdb) on the CD to the computer's hard drive.
2. Open Truck Travel Database.mdb in Access by Clicking File – Open, Highlighting Truck Travel Database in the Message Box and Clicking Open.
3. When the Security Warning "This file may not be safe if it contains code that was intended to harm your computer. Do you want to open this file or cancel the operation?" (see screenshot on the opposite page) appears, Click Open.
4. Click on File - Get External Data - Import. In the Import dialogue box, highlight the Files of Type as Microsoft Excel (*.xls) and highlight any of the previously formatted Excel workbooks (i.e., Texas County to State Flows). Click Import (see screenshot on the opposite page).

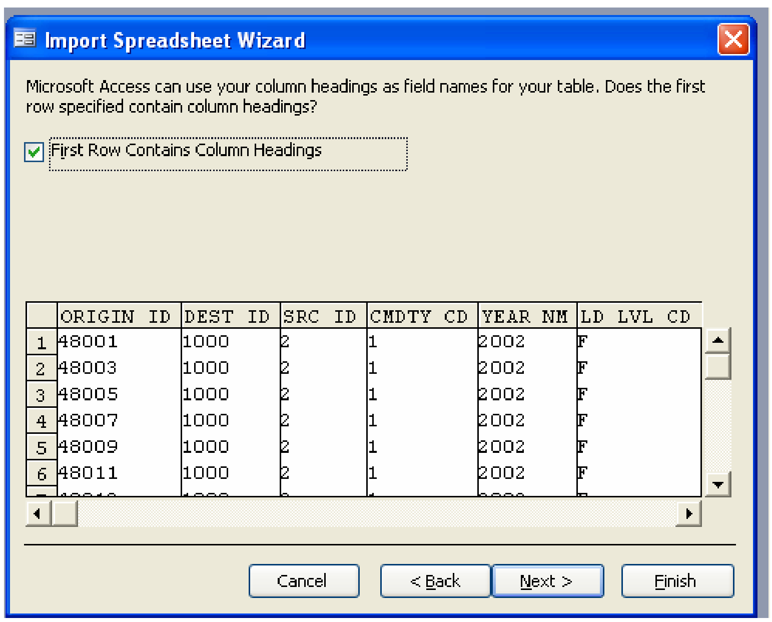

Security Warning
Opening "C:\Truck Travel Database.mdb"
This file may not be safe if it contains code that was intended to harm your computer.
Do you want to open this file or cancel the operation?
Cancel
Open
More Info

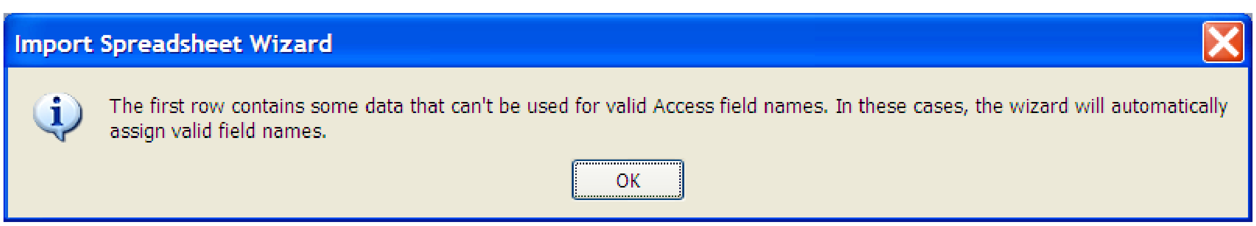

Microsoft Access
File Edit View Insert Tools Window Help
Truck Travel Database : Database (Access 2000 file format)
Open Design New
Objects
Tables
Queries
Forms
Reports
Pages
Macros
Modules
Groups
Favorites
2002 Freight Data
Commodity
Location
Source
TruckData
Import
Look in: Desktop
Tools
My Recent Documents
Desktop
My Documents
My Computer
My Network Places
Name
Size
Type
Step 2 Texas County to State Flows.xls 27,494 KB Microsoft Excel Worksheet
Step 2 State to Texas County Flows.xls 27,618 KB Microsoft Excel Worksheet
Step 1 Production Flow Distribution.xls 97 KB Microsoft Excel Worksheet
Step 1 Attraction Flow Distribution.xls 96 KB Microsoft Excel Worksheet
Intercounty Wood.xls 15,666 KB Microsoft Excel Worksheet
Intercounty Textiles.xls 15,659 KB Microsoft Excel Worksheet
Intercounty Raw Materials.xls 15,667 KB Microsoft Excel Worksheet
Intercounty Miscellaneous.xls 15,661 KB Microsoft Excel Worksheet
Intercounty Machinery.xls 15,685 KB Microsoft Excel Worksheet
Intercounty Food.xls 15,658 KB Microsoft Excel Worksheet
Intercounty Chemicals Petroleum.xls 15,656 KB Microsoft Excel Worksheet
Intercounty Building Materials.xls 15,668 KB Microsoft Excel Worksheet
Intercounty Agriculture.xls 15,652 KB Microsoft Excel Worksheet
My Network Places System Folder
File name:
Files of type: Microsoft Excel (*.xls)
Import
Cancel
dBASE III (*.dbf)
dBASE IV (*.dbf)
Microsoft Excel (*.xls)
Exchange()
HTML Documents (*.html;*.htm)
Lotus 1-2-3/DOS (*.wj*)

5. When the Import Spreadsheet Wizard dialogue box appears, select the first worksheet to be imported (e.g., Alabama). Then click Next (see screenshot on the opposite page).

6. When the next Import Spreadsheet Wizard dialogue box appears, the option "First Row Contains Column Headings" should already be selected. Click Next. If the dialogue box states the following: "The first row contains some data that can't be used for valid Access field names. In these cases, the wizard will automatically assign valid field names", close the application and return to the Excel workbooks. Make sure the worksheets are formatted appropriately. Do not allow the Access wizard to automatically assign valid field names (see screenshot on the opposite page).


Import Spreadsheet Wizard
Your spreadsheet file contains more than one worksheet or range. Which worksheet or range would you like?
Show Worksheets
Show Named Ranges
alabama
arizona
arkansas
california
colorado
connecticut
Sample data for worksheet 'alabama'.
1 ORIGIN_ID DEST_ID SRC_ID CMDTY_CD YEAR_NM LD_LVL_CD
2 48001 1000 2 1 2002 F
3 48003 1000 2 1 2002 F
4 48005 1000 2 1 2002 F
5 48007 1000 2 1 2002 F
6 48009 1000 2 1 2002 F
Cancel
< Back
Next >
Finish

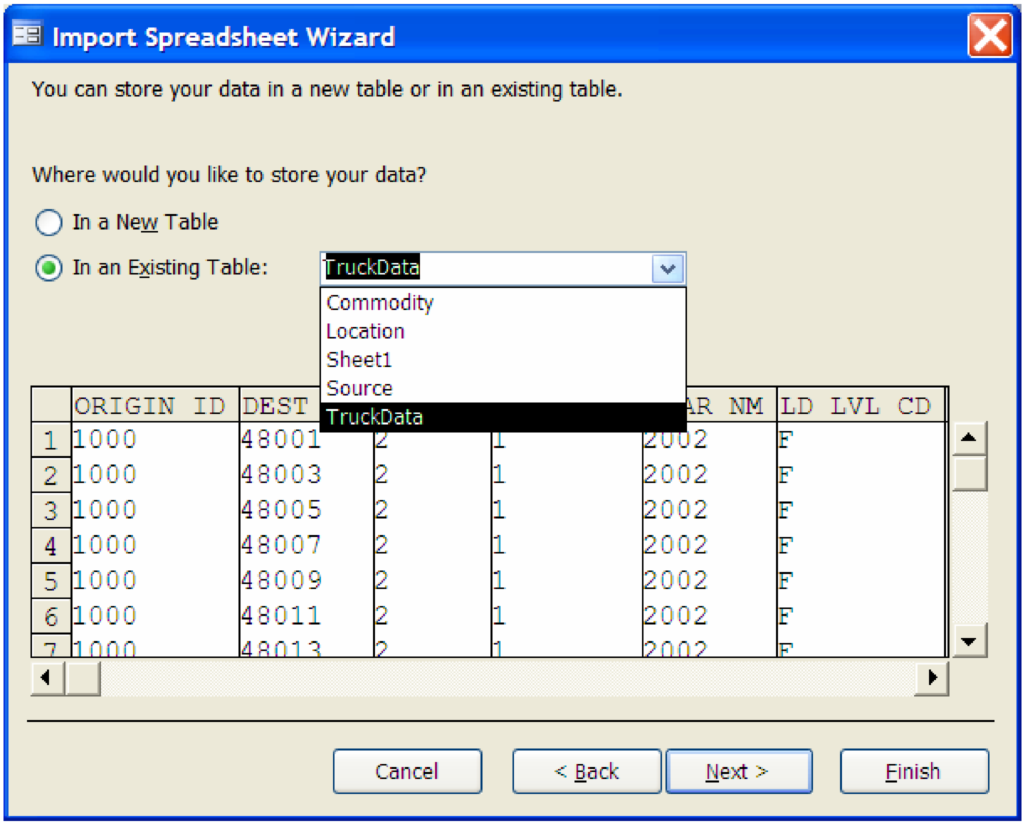

Import Spreadsheet Wizard
Microsoft Access can use your column headings as field names for your table. Does the first row specified contain column headings?
First Row Contains Column Headings
ORIGIN ID DEST ID SRC ID CMDTY CD YEAR NM LD LVL CD
1 48001 1000 2 1 2002 F
2 48003 1000 2 1 2002 F
3 48005 1000 2 1 2002 F
4 48007 1000 2 1 2002 F
5 48009 1000 2 1 2002 F
6 48011 1000 2 1 2002 F
Cancel
< Back
Next >
Finish

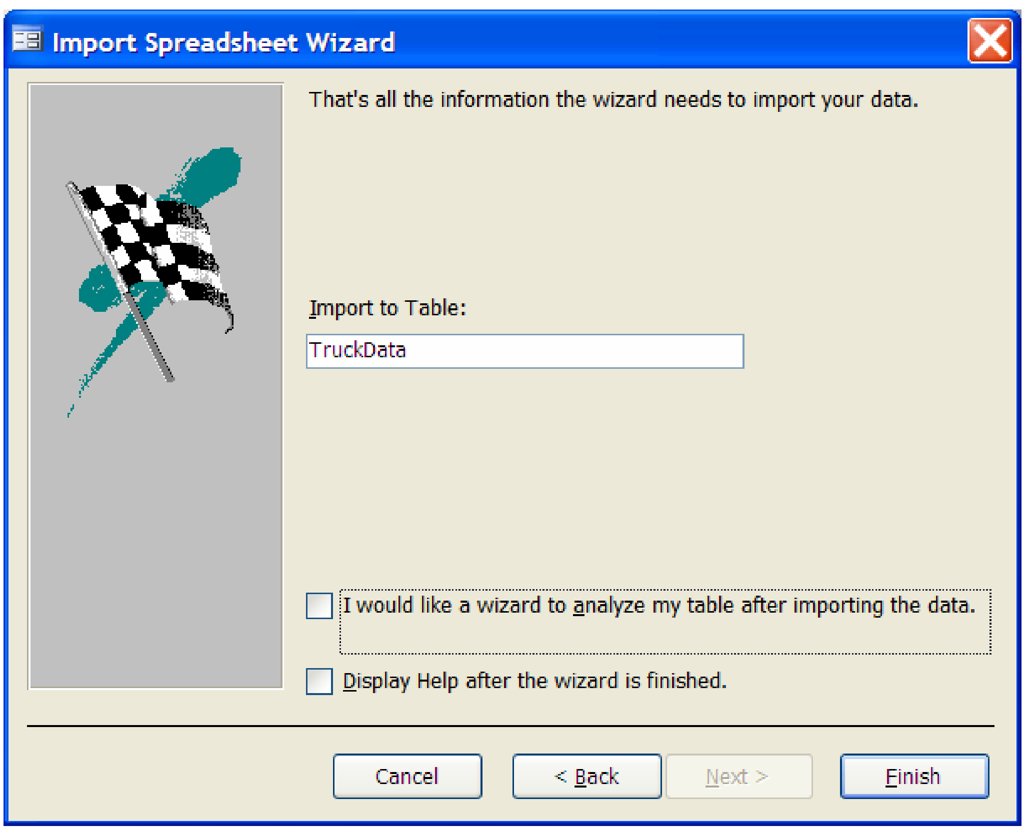

Import Spreadsheet Wizard
The first row contains some data that can't be used for valid Access field names. In these cases, the wizard will automatically assign valid field names.
OK

7. When the next Import Spreadsheet Wizard dialogue box appears, Select “In an Existing Table” and Highlight TruckData from the drop-down list box. Click Next.

8. When the next Import Spreadsheet Wizard dialogue box appears, Click Finish.

Repeat Steps 1 to 8 to import all the worksheets in the Texas County to State Flows workbook, all the worksheets in the State to Texas County Flows workbook, and the truck travel data in the 9 Intercounty commodity workbooks.


Import Spreadsheet Wizard
You can store your data in a new table or in an existing table.
Where would you like to store your data?
In a New Table
In an Existing Table:
TruckData
Commodity
Location
Sheet1
Source
TruckData
ORIGIN ID
DEST
AR NM
LD LVL CD
Cancel
< Back
Next >
Finish


Import Spreadsheet Wizard
That's all the information the wizard needs to import your data.
Import to Table:
TruckData
I would like a wizard to analyze my table after importing the data.
Display Help after the wizard is finished.
Cancel
< Back
Next >
Finish

EXPLANATION OF MODEL CALIBRATION

BACKGROUND

In TxDOT Technical Report 0-4713-R1 entitled *"Development of Sources and Methods for Securing Truck Travel Data in Texas"*, a multinomial logit (MNL) approach was presented to estimate county level truck travel data from the publicly available Commodity Flow Survey (CFS) and IMPLAN data over the short term. MNL models were first calibrated at the state-level and then used to estimate truck flows at the county level. Two state-level MNL models were developed for each commodity category included in the statewide analysis model (SAM):

- The *MNL production flow distribution model* estimates the fraction of the total productions in a state moving to each attraction state by truck based on the attributes of the attraction states and inter-state centroidal distance that serves as a proxy for the generalized cost of transportation.
- The *MNL attraction flow distribution model* estimates the fraction of the total attractions in a state originating from each of the production states by truck based on the relative production levels of the origin states and the inter-state centroidal distance that serves as a proxy for the generalized cost of transportation.

The calibrated state-level MNL production and attraction flow distribution models are then used to estimate Texas county-to-county, state-to-Texas county, and Texas county-to-state truck flows.

The steps and sub-steps followed in calibrating the models and computing the county level truck flows for Texas are as follows:

Step 1: Extract state-level commodity flows by truck mode for each commodity group to estimate production flow distribution and attraction flow distribution.

Step 2: Calculate the fractional production and attraction flows for each state and commodity group.

Step 3: Compute utility values for production flow distribution and attraction flow distribution

Step 4: Develop state-to-state centroidal distance matrix.

Step 5: Conduct linear regression analysis

(a) Production flow distribution model:

Dependent variable - utility for commodity flows to attraction states

Independent variables - distance, percentage attraction level

(b) Attraction flow distribution model:

Dependent variable - utility for commodity flows from production states

Independent variables - distance, percentage production level

Step 6: Compute disaggregate Texas county truck flows

(a) Develop state-to-county and inter-county centroidal distance matrix.

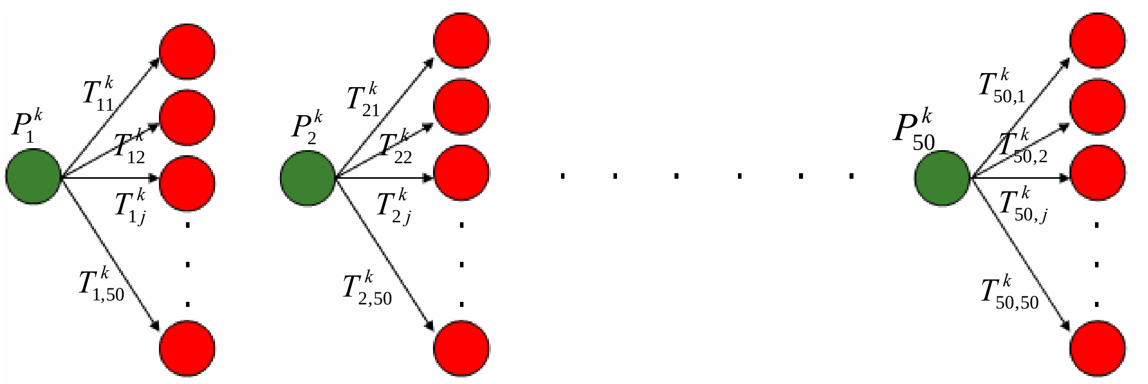
(b) Compute external-internal flows by developing county attraction levels for each commodity group and disaggregating state-to-Texas flows to Texas county level.

(c) Compute internal-external flows by developing county production levels for each commodity group and disaggregating Texas-to-State flows to Texas county level.

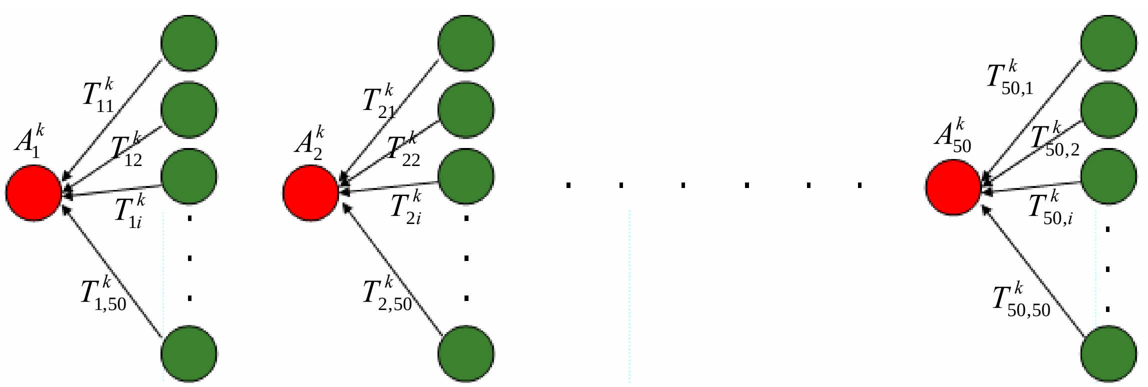
(d) Compute internal-internal flows by disaggregating Texas intrastate flows to generate Texas county-to-county flows.

Step 1: Extract state-level commodity flows by truck mode for each commodity group to estimate production flow distribution and attraction flow distribution

The movement of commodity flows between states can be represented as production flows from an origin state and attraction flows to a destination state. Specifically, the annual truck flows (tonnage) from each production state to the 50 attraction states for each commodity group can be represented as follows:



Similarly, the annual truck flows (tonnage) attracted to each state from the fifty production states for commodity group *k* can be illustrated as follows:



The production/attraction truck flow information needed to calibrate the production flow distribution MNL model and the attraction flow distribution MNL model was extracted from the 1997 Commodity Flow Survey (CFS) and aggregated into nine commodity groups. The nine commodity groups are presented in Table 1.

Table 1: Detailed Commodity Groups

Commodity Group		Commodity Categories
1.	Agriculture	Live animals and live fish
		Cereal grains
		Other agricultural products
		Animal feed and products of animal origin, n.e.c.
2.	Food	Meat, fish, seafood, and their preparations
		Milled grain products and preparations, and bakery products
		Other prepared foodstuffs and fats and oils
		Alcoholic Beverages
		Tobacco Products
3.	Building materials	Monumental or building stone
		Nonmetallic mineral products
		Base metal in primary or semi finished forms and in finished basic shapes
		Articles of base metal
4.	Raw material	Natural sands
		Gravel and crushed stone
		Nonmetallic minerals n.e.c.
		Metallic ores and concentrates
		Coal
5.	Chemicals/Petroleum	Gasoline and aviation turbine fuel
		Fuel oils
		Coal and petroleum products, n.e.c.
		Basic chemicals
		Pharmaceutical products
		Fertilizers
		Chemical products and preparations, n.e.c.
6.	Wood	Logs and other wood in the rough
		Wood products
		Pulp, newsprint, paper, and paperboard
		Paper or paperboard articles
		Printed products
		Furniture, mattresses and mattress supports, lamps, lighting fittings, and...
7.	Textiles	Plastics and rubber
		Textiles, leather, and articles of textiles or leather
8.	Machinery	Machinery
		Electronic and other electrical equipment, components and office equipment
		Motorized and other vehicles (including parts)
		Transportation equipment, n.e.c.
		Precision instruments and apparatus
		Miscellaneous manufactured products
9.	Miscellaneous	Waste and scrap
		Mixed freight

NOTE: Since detailed data on the movement of secondary and hazardous shipments by truck were not available from the CFS, these shipments have not been considered. Based on available literature, the percentage of inter-city and interstate truck flows of secondary and hazardous shipments is low compared to the flows of the major commodity groups considered. Therefore, the overall impact on the total truck flow estimates of not considering secondary and hazardous shipments is believed to be small.

Step 1 (a): Compile a table with the production flow distributions from each production state to all attraction states for each of the nine commodity groups

The required steps to generate the production flow table are as follows:

- Extract the required data (state origin, state destination, commodity value, commodity tonnage moved by trucks) for flows from **each production state** to **all attraction States** from the CFS and enter the data into an excel workbook (see Production Flow Distribution on the CD). In the 1997 CFS, these data variables could be extracted from "StatesTbl15(1997): Shipment characteristics by 2 digit commodity and mode of transportation". Also note that in 1997 the tonnage was in thousands of tons.
- Group the commodity information into the commodity groups shown in Table 1.
- Sum the value and tonnage for all commodities belonging to the same group to obtain the total flows for each commodity group from each production state to each attraction state. The excel screenshot displays the data for each of the commodities and the total tonnage and value of truck flows aggregated in the commodity groups from production state Alabama to attraction states Alabama, Arizona, Arkansas, California, and Colorado.

Microsoft Excel - Step 1 Production Flow Distribution.xls

	A	B	C	D	E	F	G	H	I	J	K
1	**ORIGIN: ALABAMA**	**Alabama**		**Arizona**		**Arkansas**		**California**		**Colorado**	
2		**Value($ mil)**	**Tons(000)**	**Value($ mil)**	**Tons(000)**	**Value($ mil)**	**Tons(000)**	**Value($ mil)**	**Tons(000)**	**Value($ mil)**	**Tons(0(**
3											
4	All commodities	30508	144368	145	69	1047	767	1405	536	-	1
5											
6	Live animals and live fish	10	9	-	-	-	-	-	-	-	-
7	Cereal grains	-	-	-	-	-	-	-	-	-	-
8	Other agricultural products	423	-	-	-	-	-	-	-	-	-
9	Animal feed and products of animal origin,	984	5581	-	-	-	-	-	-	-	-
10	**Agriculture**	**1417**	**5590**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
11											
12	Meat, fish, seafood, and their preparations	629	406	-	-	190	87	127	90	-	-
13	Milled grain products and preparations, and	206	172	-	-	-	-	-	-	-	-
14	Other prepared foodstuffs and fats and oils	1483	2521	-	-	4	-	25	-	-	-
15	Alcoholic beverages	629	475	-	-	-	-	-	-	-	-
16	Tobacco products	486	26	-	-	-	-	-	-	-	-
17	**Food**	**3433**	**3600**	**0**	**0**	**194**	**87**	**152**	**90**	**0**	
18											
19	Monumental or building stone	-	-	-	-	-	-	-	-	-	-
20	Nonmetallic mineral products	753	11302	-	-	-	-	-	-	-	-
21	Base metal in primary or semifinished form	1448	2608	-	-	88	71	48	-	-	-
22	Articles of base metal	976	611	13	-	46	38	58	38	17	
23	**Building Materials**	**3177**	**14521**	**13**	**0**	**134**	**109**	**106**	**38**	**17**	
24											
25	Natural sands	-	-	-	-	-	-	-	-	-	-
26	Gravel and crushed stone	167	28756	-	-	-	-	-	-	-	-
27	Nonmetallic minerals n.e.c.	-	871	-	-	-	-	-	-	-	-
28	Metallic ores and concentrates	-	-	-	-	-	-	-	-	-	-
29	Coal	369	10241	-	-	-	-	-	-	-	-
30	**Raw Materials**	**536**	**39868**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
31											
31											
32	Gasoline and aviation turbine fuel	3330	12296	-	-	-	-	-	-	-	-
33	Fuel oils	735	3326	-	-	-	-	-	-	-	-
34	Coal and petroleum products, n.e.c.	240	1681	-	-	-	-	-	-	-	-
35	Basic chemicals	406	1096	-	-	-	65	16	-	-	-
36	Pharmaceutical products	411	19	-	-	-	-	-	-	-	-
37	Fertilizers	91	603	-	-	-	-	-	-	-	-
38	Chemical products and preparations, n.e.c	441	212	-	-	87	21	-	-	-	-
39	**Chemicals/Petroleum**	**5654**	**19233**	**0**	**0**	**87**	**86**	**16**	**0**	**0**	
40											
41	Logs and other wood in the rough	721	32047	-	-	-	-	-	-	-	-
42	Wood products	1324	5734	-	-	42	110	-	7	-	-
43	Pulp, newsprint, paper, and paperboard	680	1312	-	-	20	46	108	134	-	-
44	Paper or paperboard articles	429	546	-	-	-	-	8	1	-	-
45	Printed products	531	129	-	-	-	-	-	-	-	-
46	Furniture, mattresses and mattress suppo	270	49	16	-	-	5	49	11	35	-
47	**Wood**	**3955**	**39817**	**16**	**0**	**62**	**161**	**165**	**153**	**35**	
48											
49	Plastics and rubber	755	297	-	-	-	-	127	53	-	-
50	Textiles, leather, and articles of textiles or	3312	585	-	-	130	32	353	46	-	-
51	**Textiles**	**4067**	**882**	**0**	**0**	**130**	**32**	**480**	**99**	**0**	
52											
53	Machinery	1550	241	-	-	72	13	61	-	-	-
54	Electronic and other electrical equipment a	1122	206	-	-	5	-	250	20	-	-
55	Motorized and other vehicles (including par	815	185	-	-	14	7	-	-	-	-
56	Transportation equipment, n.e.c.	4	-	-	-	-	-	19	1	-	-
57	Precision instruments and apparatus	24	-	-	-	-	-	-	-	-	-
58	Miscellaneous manufactured products	2443	884	-	-	89	45	20	5	-	-
59	**Machinery**	**5958**	**1516**	**0**	**0**	**180**	**65**	**350**	**26**	**0**	
60											
61	Waste and scrap	191	1232	-	-	-	-	-	-	-	-
62	Mixed freight	1638	999	-	-	-	-	-	-	-	-
63	**Miscellaneous**	**1829**	**2231**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	

alabama / arizona / arkansas / california / colorado / connecticut / delaware / DOC / flori(

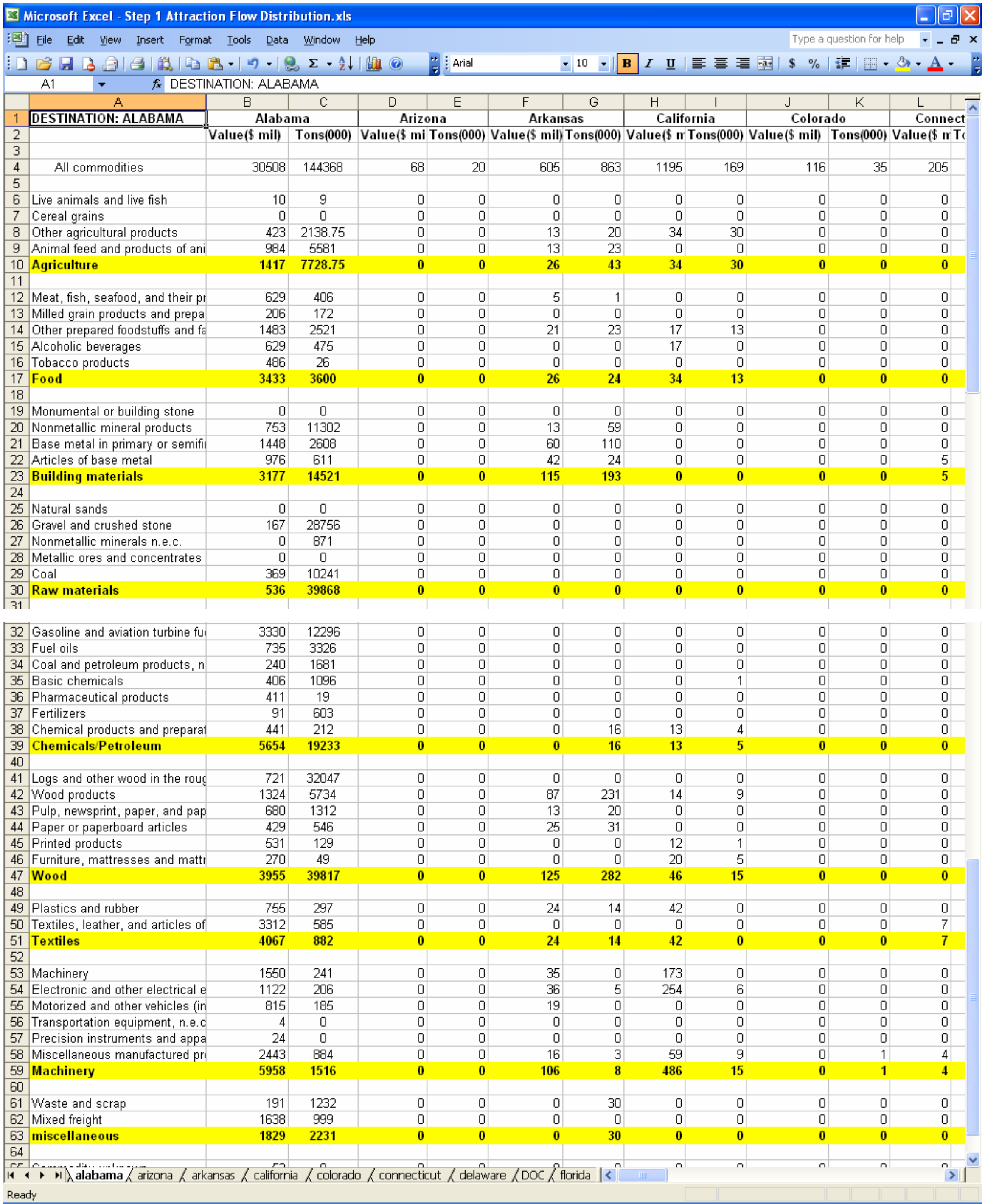
Ready

NOTE: This data relates to the truck tonnage and value moved between **each production state** and **each attraction state.** In other words there will be a total of 50 worksheets (one for each production state). Each worksheet contains 100 columns that capture the tonnage and dollar flows by commodity to each attraction state from the specific production state.

Step 1 (b): Compile a table with the attraction flow distributions from all production states to each attraction state for each of the nine commodity groups

The procedure to generate the attraction flow distribution table for each commodity group is similar to that for the production flow distribution table. The required steps to generate the attraction flow table are as follows:

- Extract the required data (state destination, state origin, commodity value, commodity tonnage moved by trucks) for flows destined to **each attraction state** from **all production states** from the CFS and enter the data into an excel workbook (see Attraction Flow Distribution on the CD). In the 1997 CFS, these data variables could be extracted from "StatesTbl15(1997): Shipment characteristics by 2 digit commodity and mode of transportation". Also note that in 1997 the tonnage was in thousands of tons.
- Group the commodity information into the commodity groups shown in Table 1.
- Sum the value and tonnage for all commodities belonging to the same group to obtain the total flows for each commodity group destined for each attraction state from each production state. The excel screenshot displays the data for each of the commodities and the total tonnage and value of truck flows aggregated in the commodity groups destined for attraction state Alabama from production states Alabama, Arizona, Arkansas, California, Colorado, and Connecticut.



Microsoft Excel - Step 1 Attraction Flow Distribution.xls

A	B	C	D	E	F	G	H	I	J	K	L
DESTINATION: ALABAMA	Alabama		Arizona		Arkansas		California		Colorado		Connect
	Value($ mil)	Tons(000)	Value($ mi	Tons(000)	Value($ mil)	Tons(000)	Value($ m	Tons(000)	Value($ mil)	Tons(000)	Value($ m
All commodities	30508	144368	68	20	605	863	1195	169	116	35	205
Live animals and live fish	10	9	0	0	0	0	0	0	0	0	0
Cereal grains	0	0	0	0	0	0	0	0	0	0	0
Other agricultural products	423	2138.75	0	0	13	20	34	30	0	0	0
Animal feed and products of ani	984	5581	0	0	13	23	0	0	0	0	0
Agriculture	**1417**	**7728.75**	**0**	**0**	**26**	**43**	**34**	**30**	**0**	**0**	**0**
Meat, fish, seafood, and their pr	629	406	0	0	5	1	0	0	0	0	0
Milled grain products and prepa	206	172	0	0	0	0	0	0	0	0	0
Other prepared foodstuffs and fa	1483	2521	0	0	21	23	17	13	0	0	0
Alcoholic beverages	629	475	0	0	0	0	17	0	0	0	0
Tobacco products	486	26	0	0	0	0	0	0	0	0	0
Food	**3433**	**3600**	**0**	**0**	**26**	**24**	**34**	**13**	**0**	**0**	**0**
Monumental or building stone	0	0	0	0	0	0	0	0	0	0	0
Nonmetallic mineral products	753	11302	0	0	13	59	0	0	0	0	0
Base metal in primary or semifi	1448	2608	0	0	60	110	0	0	0	0	0
Articles of base metal	976	611	0	0	42	24	0	0	0	0	5
Building materials	**3177**	**14521**	**0**	**0**	**115**	**193**	**0**	**0**	**0**	**0**	**5**
Natural sands	0	0	0	0	0	0	0	0	0	0	0
Gravel and crushed stone	167	28756	0	0	0	0	0	0	0	0	0
Nonmetallic minerals n.e.c.	0	871	0	0	0	0	0	0	0	0	0
Metallic ores and concentrates	0	0	0	0	0	0	0	0	0	0	0
Coal	369	10241	0	0	0	0	0	0	0	0	0
Raw materials	**536**	**39868**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Gasoline and aviation turbine fu	3330	12296	0	0	0	0	0	0	0	0	0
Fuel oils	735	3326	0	0	0	0	0	0	0	0	0
Coal and petroleum products, n	240	1681	0	0	0	0	0	0	0	0	0
Basic chemicals	406	1096	0	0	0	0	0	1	0	0	0
Pharmaceutical products	411	19	0	0	0	0	0	0	0	0	0
Fertilizers	91	603	0	0	0	0	0	0	0	0	0
Chemical products and preparat	441	212	0	0	0	16	13	4	0	0	0
Chemicals/Petroleum	**5654**	**19233**	**0**	**0**	**0**	**16**	**13**	**5**	**0**	**0**	**0**
Logs and other wood in the roug	721	32047	0	0	0	0	0	0	0	0	0
Wood products	1324	5734	0	0	87	231	14	9	0	0	0
Pulp, newsprint, paper, and pap	680	1312	0	0	13	20	0	0	0	0	0
Paper or paperboard articles	429	546	0	0	25	31	0	0	0	0	0
Printed products	531	129	0	0	0	0	12	1	0	0	0
Furniture, mattresses and mattr	270	49	0	0	0	0	20	5	0	0	0
Wood	**3955**	**39817**	**0**	**0**	**125**	**282**	**46**	**15**	**0**	**0**	**0**
Plastics and rubber	755	297	0	0	24	14	42	0	0	0	0
Textiles, leather, and articles of	3312	585	0	0	0	0	0	0	0	0	7
Textiles	**4067**	**882**	**0**	**0**	**24**	**14**	**42**	**0**	**0**	**0**	**7**
Machinery	1550	241	0	0	35	0	173	0	0	0	0
Electronic and other electrical e	1122	206	0	0	36	5	254	6	0	0	0
Motorized and other vehicles (in	815	185	0	0	19	0	0	0	0	0	0
Transportation equipment, n.e.c	4	0	0	0	0	0	0	0	0	0	0
Precision instruments and appa	24	0	0	0	0	0	0	0	0	0	0
Miscellaneous manufactured pr	2443	884	0	0	16	3	59	9	0	1	4
Machinery	**5958**	**1516**	**0**	**0**	**106**	**8**	**486**	**15**	**0**	**1**	**4**
Waste and scrap	191	1232	0	0	0	30	0	0	0	0	0
Mixed freight	1638	999	0	0	0	0	0	0	0	0	0
miscellaneous	**1829**	**2231**	**0**	**0**	**0**	**30**	**0**	**0**	**0**	**0**	**0**

alabama / arizona / arkansas / california / colorado / connecticut / delaware / DOC / florida

NOTE: Although the procedure for generating the attraction flow distribution table is similar to that for the production flow distribution table, caution should be taken to ensure that the appropriate data is extracted. In other words, for the attraction flow distribution table the analyst needs to extract the commodity data destined for each state from all other states. In the case of the production flow distribution table, the analyst needs to extract the commodity data originating in each state destined for all other states.

Step 2: Calculate percentage productions and attractions for each state and commodity group

To calibrate the production flow distribution and attraction flow distribution MNL models, the percentage production and attraction levels of each State for each commodity group, respectively are needed. The required steps and the essence of the formulas for calculating the percentage productions in and attractions to each state are similar. Calculating the percentage productions in each state are thus subsequently used to illustrate the procedure. The same procedure needs to be followed to calculate the total attractions of each commodity group to each state.

Step 2 (a): Calculate the total productions of each commodity group in each state

The total production flows of each commodity group in each production state are obtained by adding the total flows from each production state to all attraction states by commodity group. Mathematically, the latter is expressed as follows:

$$P_i^k = \sum_{j=1}^{50} T_{ij}^k$$

Where T_{ij}^k = Annual tonnage of truck flows of commodity group *k* (*k* = 1 to 9) from production state *i* (*i* = 1 to 50) to attraction state *j* (*j* = 1 to 50).

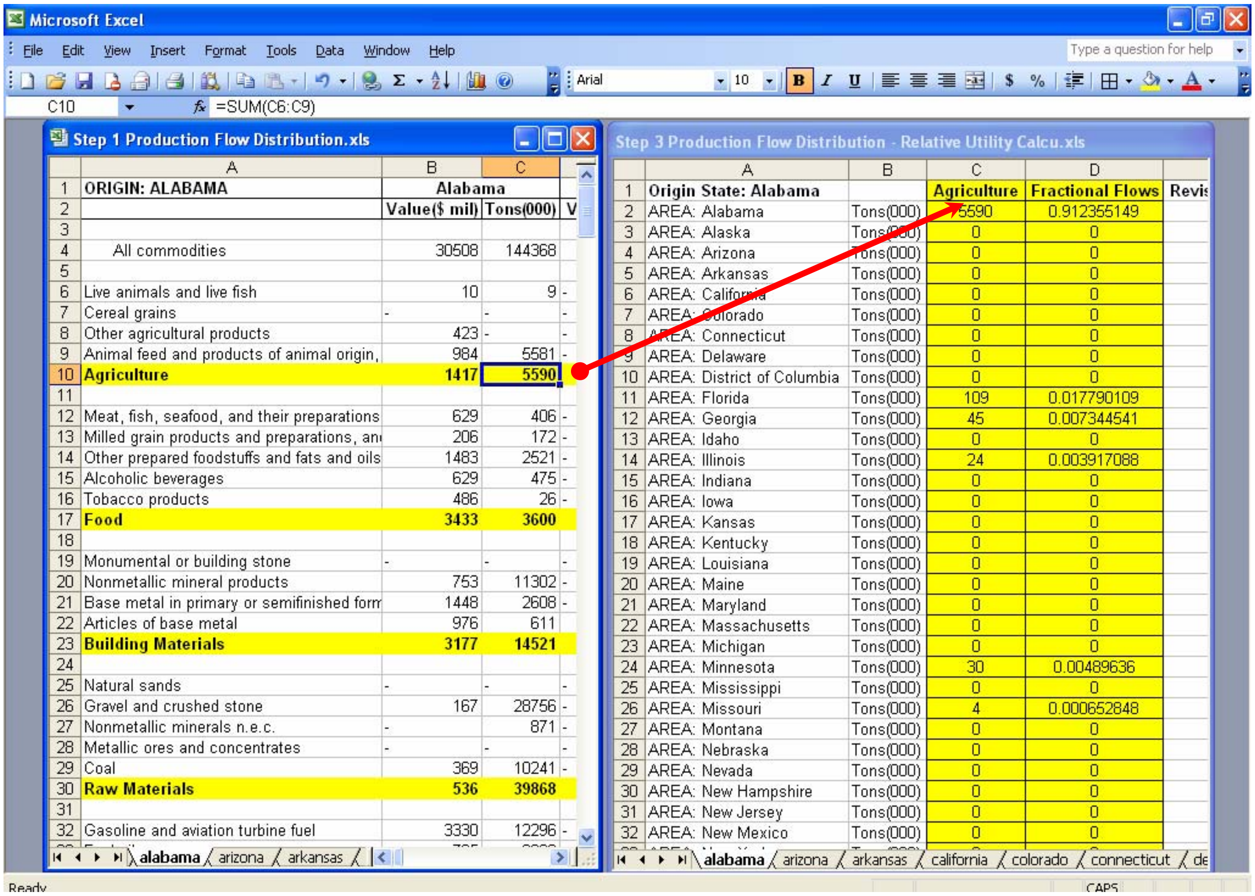
The total production flows of each commodity group from each production state are calculated in the workbook titled Production Flow Distribution – Relative Utility Calcu on the CD from the production flow distribution table compiled (see Production Flow Distribution on the CD). Agricultural production flows from Alabama to all other states are used to illustrate the concept. First, the agricultural production flows from production state Alabama to each of the states are copied to/linked to the Production Flow Distribution – Relative Utility Calcu workbook (see screenshot on the opposite page).

The total attraction flows of each commodity group destined for each attraction state are obtained by adding the total flows to each attraction state from all production states by commodity group. Mathematically, the latter is expressed as follows:

$$A_j^k = \sum_{i=1}^{50} T_{ij}^k$$

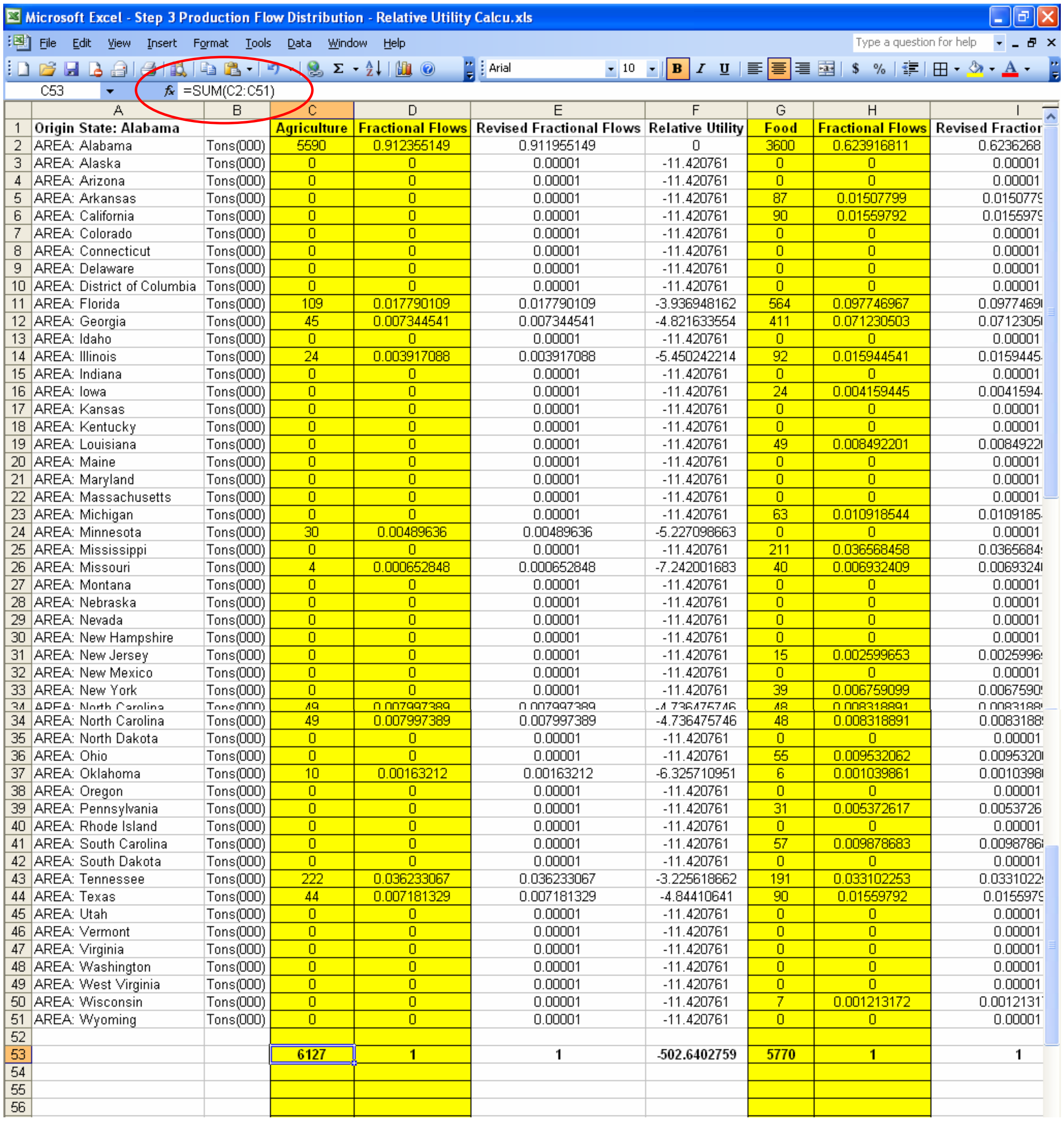
Where T_{ij}^k = Annual tonnage of truck flows of commodity group *k* (*k* = 1 to 9) to attraction state *j* (*j* = 1 to 50) from production state *i* (*i* = 1 to 50).

The total attraction flows of each commodity group destined for each attraction state are calculated in the workbook titled Attraction Flow Distribution – Relative Utility Calcu on the CD from the attraction flow distribution table compiled in Step 1 (see Attraction Flow Distribution on the CD).



Note: Both the Step 2 and 3 calculations are done in the Production Flow Distribution – Relative Utility Calcu workbook.

Second, the total production flows of agricultural commodities from all production states are calculated by summing the agricultural production flows from each of the states listed in the Production Flow Distribution – Relative Utility Calcu workbook (see screenshot on the opposite page).



Microsoft Excel - Step 3 Production Flow Distribution - Relative Utility Calcu.xls

C53 =SUM(C2:C51)

	A	B	C	D	E	F	G	H	I
1	Origin State: Alabama		Agriculture	Fractional Flows	Revised Fractional Flows	Relative Utility	Food	Fractional Flows	Revised Fraction
2	AREA: Alabama	Tons(000)	5590	0.912355149	0.911955149	0	3600	0.623916811	0.6236268
3	AREA: Alaska	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
4	AREA: Arizona	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
5	AREA: Arkansas	Tons(000)	0	0	0.00001	-11.420761	87	0.01507799	0.0150779
6	AREA: California	Tons(000)	0	0	0.00001	-11.420761	90	0.01559792	0.0155979
7	AREA: Colorado	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
8	AREA: Connecticut	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
9	AREA: Delaware	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
10	AREA: District of Columbia	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
11	AREA: Florida	Tons(000)	109	0.017790109	0.017790109	-3.936948162	564	0.097746967	0.0977469
12	AREA: Georgia	Tons(000)	45	0.007344541	0.007344541	-4.821633554	411	0.071230503	0.0712305
13	AREA: Idaho	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
14	AREA: Illinois	Tons(000)	24	0.003917088	0.003917088	-5.450242214	92	0.015944541	0.0159445
15	AREA: Indiana	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
16	AREA: Iowa	Tons(000)	0	0	0.00001	-11.420761	24	0.004159445	0.0041594
17	AREA: Kansas	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
18	AREA: Kentucky	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
19	AREA: Louisiana	Tons(000)	0	0	0.00001	-11.420761	49	0.008492201	0.0084922
20	AREA: Maine	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
21	AREA: Maryland	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
22	AREA: Massachusetts	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
23	AREA: Michigan	Tons(000)	0	0	0.00001	-11.420761	63	0.010918544	0.0109185
24	AREA: Minnesota	Tons(000)	30	0.00489636	0.00489636	-5.227098663	0	0	0.00001
25	AREA: Mississippi	Tons(000)	0	0	0.00001	-11.420761	211	0.036568458	0.0365684
26	AREA: Missouri	Tons(000)	4	0.000652848	0.000652848	-7.242001683	40	0.006932409	0.0069324
27	AREA: Montana	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
28	AREA: Nebraska	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
29	AREA: Nevada	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
30	AREA: New Hampshire	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
31	AREA: New Jersey	Tons(000)	0	0	0.00001	-11.420761	15	0.002599653	0.0025996
32	AREA: New Mexico	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
33	AREA: New York	Tons(000)	0	0	0.00001	-11.420761	39	0.006759099	0.0067590
34	AREA: North Carolina	Tons(000)	49	0.007997389	0.007997389	-4.736475746	48	0.008318891	0.0083188
35	AREA: North Dakota	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
36	AREA: Ohio	Tons(000)	0	0	0.00001	-11.420761	55	0.009532062	0.0095320
37	AREA: Oklahoma	Tons(000)	10	0.00163212	0.00163212	-6.325710951	6	0.001039861	0.0010398
38	AREA: Oregon	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
39	AREA: Pennsylvania	Tons(000)	0	0	0.00001	-11.420761	31	0.005372617	0.0053726
40	AREA: Rhode Island	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
41	AREA: South Carolina	Tons(000)	0	0	0.00001	-11.420761	57	0.009878683	0.0098786
42	AREA: South Dakota	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
43	AREA: Tennessee	Tons(000)	222	0.036233067	0.036233067	-3.225618662	191	0.033102253	0.0331022
44	AREA: Texas	Tons(000)	44	0.007181329	0.007181329	-4.84410641	90	0.01559792	0.0155979
45	AREA: Utah	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
46	AREA: Vermont	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
47	AREA: Virginia	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
48	AREA: Washington	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
49	AREA: West Virginia	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
50	AREA: Wisconsin	Tons(000)	0	0	0.00001	-11.420761	7	0.001213172	0.0012131
51	AREA: Wyoming	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
52									
53			6127	1	1	-502.6402759	5770	1	1
54									
55									
56									

Note: The values in the “revised fractional flows” and the “relative utility” columns are calculated in Step 3.

Step 2 (b): Calculate the fractional production and attraction flows for each state and commodity group

The fractional production flows of each commodity group destined for state j from production state i are calculated as follows:

$$FP_{ij}^{k} = \frac{T_{ij}^{k}}{P_{i}^{k}}$$

Where,

T_{ij}^{k} = Annual tonnage of truck flows of commodity group k (k = 1 to 9) from production state i (i = 1 to 50) to attraction state j (j = 1 to 50)

P_{i}^{k} = Total productions of commodity group k in production state i

The calculation is illustrated on the opposite page.

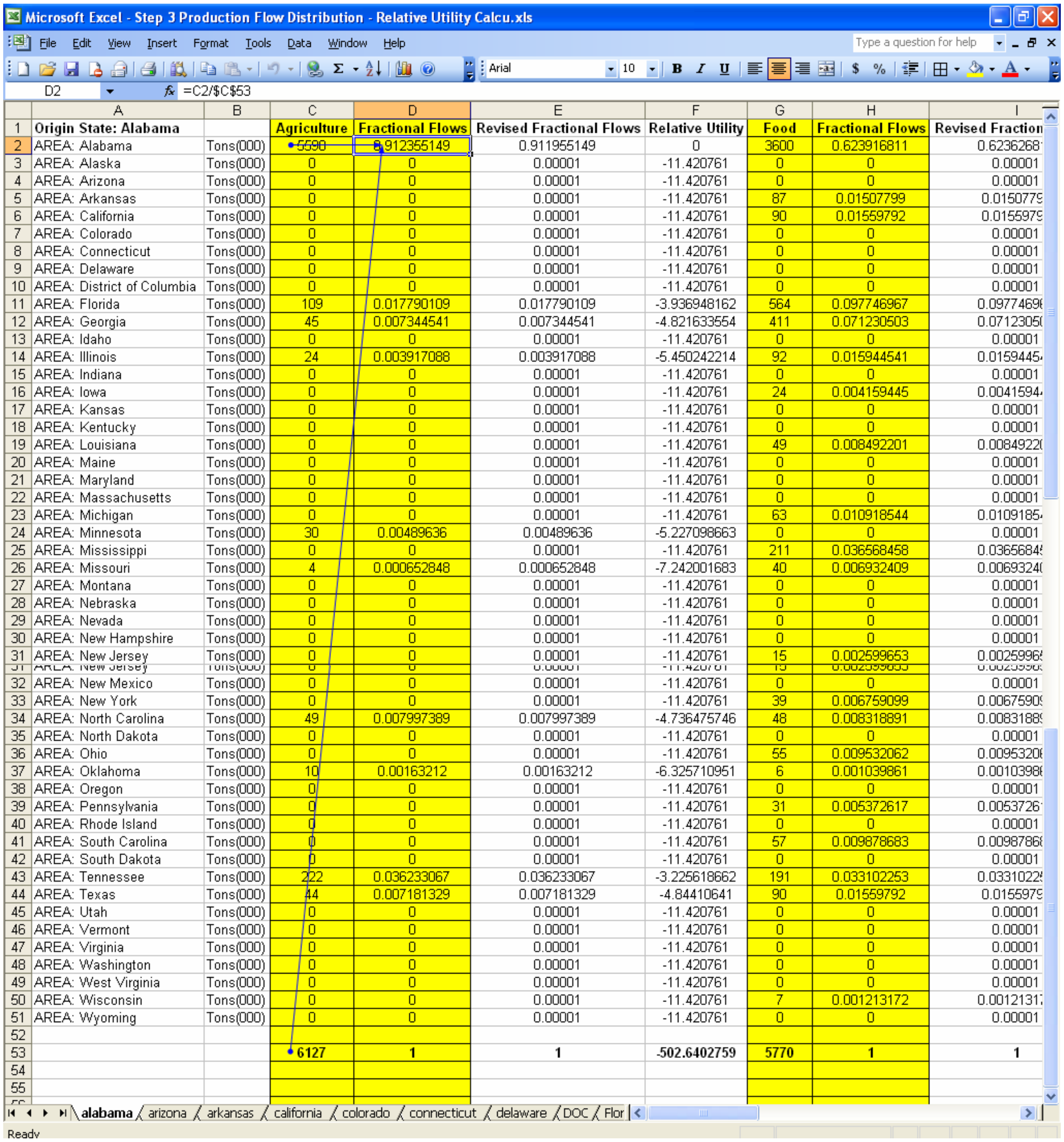
The fractional attraction flows of each commodity group attracted to state j from production state i are calculated as follows:

$$FA_{ij}^{k} = \frac{T_{ij}^{k}}{A_{j}^{k}}$$

Where,

T_{ij}^{k} = Annual tonnage of truck flows of commodity group k (k = 1 to 9) to attraction state j (j = 1 to 50) from production state i (i = 1 to 50).

A_{j}^{k} = Total attractions of commodity group k to attraction state j



Microsoft Excel - Step 3 Production Flow Distribution - Relative Utility Calcu.xls

D2 =C2/$C$53

	A	B	C	D	E	F	G	H	I
1	**Origin State: Alabama**		**Agriculture**	**Fractional Flows**	**Revised Fractional Flows**	**Relative Utility**	**Food**	**Fractional Flows**	**Revised Fraction**
2	AREA: Alabama	Tons(000)	5590	0.912355149	0.911955149	0	3600	0.623916811	0.6236268
3	AREA: Alaska	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
4	AREA: Arizona	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
5	AREA: Arkansas	Tons(000)	0	0	0.00001	-11.420761	87	0.01507799	0.0150779
6	AREA: California	Tons(000)	0	0	0.00001	-11.420761	90	0.01559792	0.0155979
7	AREA: Colorado	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
8	AREA: Connecticut	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
9	AREA: Delaware	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
10	AREA: District of Columbia	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
11	AREA: Florida	Tons(000)	109	0.017790109	0.017790109	-3.936948162	564	0.097746967	0.0977469
12	AREA: Georgia	Tons(000)	45	0.007344541	0.007344541	-4.821633554	411	0.071230503	0.0712305
13	AREA: Idaho	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
14	AREA: Illinois	Tons(000)	24	0.003917088	0.003917088	-5.450242214	92	0.015944541	0.0159445
15	AREA: Indiana	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
16	AREA: Iowa	Tons(000)	0	0	0.00001	-11.420761	24	0.004159445	0.0041594
17	AREA: Kansas	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
18	AREA: Kentucky	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
19	AREA: Louisiana	Tons(000)	0	0	0.00001	-11.420761	49	0.008492201	0.0084922
20	AREA: Maine	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
21	AREA: Maryland	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
22	AREA: Massachusetts	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
23	AREA: Michigan	Tons(000)	0	0	0.00001	-11.420761	63	0.010918544	0.0109185
24	AREA: Minnesota	Tons(000)	30	0.00489636	0.00489636	-5.227098663	0	0	0.00001
25	AREA: Mississippi	Tons(000)	0	0	0.00001	-11.420761	211	0.036568458	0.0365684
26	AREA: Missouri	Tons(000)	4	0.000652848	0.000652848	-7.242001683	40	0.006932409	0.0069324
27	AREA: Montana	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
28	AREA: Nebraska	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
29	AREA: Nevada	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
30	AREA: New Hampshire	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
31	AREA: New Jersey	Tons(000)	0	0	0.00001	-11.420761	15	0.002599653	0.0025996
32	AREA: New Mexico	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
33	AREA: New York	Tons(000)	0	0	0.00001	-11.420761	39	0.006759099	0.0067590
34	AREA: North Carolina	Tons(000)	49	0.007997389	0.007997389	-4.736475746	48	0.008318891	0.0083188
35	AREA: North Dakota	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
36	AREA: Ohio	Tons(000)	0	0	0.00001	-11.420761	55	0.009532062	0.0095320
37	AREA: Oklahoma	Tons(000)	10	0.00163212	0.00163212	-6.325710951	6	0.001039861	0.0010398
38	AREA: Oregon	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
39	AREA: Pennsylvania	Tons(000)	0	0	0.00001	-11.420761	31	0.005372617	0.0053726
40	AREA: Rhode Island	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
41	AREA: South Carolina	Tons(000)	0	0	0.00001	-11.420761	57	0.009878683	0.0098786
42	AREA: South Dakota	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
43	AREA: Tennessee	Tons(000)	222	0.036233067	0.036233067	-3.225618662	191	0.033102253	0.0331022
44	AREA: Texas	Tons(000)	44	0.007181329	0.007181329	-4.84410641	90	0.01559792	0.0155979
45	AREA: Utah	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
46	AREA: Vermont	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
47	AREA: Virginia	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
48	AREA: Washington	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
49	AREA: West Virginia	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
50	AREA: Wisconsin	Tons(000)	0	0	0.00001	-11.420761	7	0.001213172	0.0012131
51	AREA: Wyoming	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
52									
53			**6127**	**1**	**1**	**-502.6402759**	**5770**	**1**	**1**
54									
55									

alabama / arizona / arkansas / california / colorado / connecticut / delaware / DOC / Flor

Ready

Step 3: Compute Utility Values for Production Flow Distribution and Attraction Flow Distribution

In calibrating the MNL production flow distribution and attraction flow distribution models, utility values have to be calculated for each because the factors impacting the flows differ in these two cases. The process for computing the utility values is, however, similar.

Step 3(a): Compute Utility Values for Production Flow Distribution Model

In the production flow distribution model, the utility values represent the propensity for flows from production state *i* to each of the attraction states *j*. From the definition of the MNL model, the fraction of the total production flows of commodity group *k* from production state *i* to state *j* among *n* alternative states can be expressed as follows:

$$FP_{ij}^{k} = \frac{e^{V_{ij}^{k}}}{\sum_{j=1}^{n} e^{V_{ij}^{k}}}$$

Where,

V_{ij}^{k} = Utility value for flows from state *i* to state *j* for commodity group *k*

During Step 3(a) the utility values for production flows from each production state to each attraction state for each commodity group is calculated. Agricultural production flows from Alabama to all other states are used to illustrate the computation of the utility values.

The steps involved in computing the utility values are:

1. Examination of the fractional production flows calculated in Step 2(b) (see Column D in the Excel workbook Production Flow Distribution – Relative Utility Calcu on the CD) reveals that in a number of cases the production flows from Alabama to some of the attraction states are zero. If the production flows are zero, the utility value will be negative infinity and therefore undetermined (given the mathematical equation of the logit model). The fractional production flows therefore needs to be adjusted so that utility values can be computed for all flows from each production state to each attraction state.

   The utility values for zero flows can be approximated through a minor adjustment to the fractional flows. The adjustment involves replacing the zeros with a very small value (0.00001) to ensure that the computed utilities have a high negative value. Also, since the total fractional production flows have to equal 1, the added adjusted flows (= 0.00001 * number of cells with zero flows) must be deducted from the flows in another cell(s) to ensure that the total fractional production flows sum to 1. For simplicity, the added adjusted flows were subtracted from the cell containing the highest fractional flows.

2. Once the revised fractional flows from Alabama to each attraction state are calculated, the utilities can be computed using the MNL equation on page x.

   a. The utility values for production flows from Alabama to each attraction state are the unknowns that need to be calculated. Thus, there are a total of 50 unknowns. Applying the MNL equation to production flows from Alabama to each attraction state results in 49 independent equations.[2] Thus, there are 49 independent equations and 50 unknowns to solve. This is addressed by assigning the utility value for flows from Alabama to an arbitrary state *s* as zero and computing the utilities for production flows to the remaining states relative to the utility for flows to state *s.* The latter is referred to as the base utility since the utilities for flows from Alabama to all the other attraction states are relative to the utility for flows from Alabama to state *s*. Given the base utility value, there are 49 utility unknowns to be determined from 49 independent equations.

   b. In this example, the utility for agricultural production flows from Alabama to Alabama is assumed to be zero. The next step is to substitute the zero value and the revised fractional agricultural production flows in the MNL equation as follows:

$$0.911955149 = \frac{e^0}{\sum_{j=1}^{49} e^{V_{Al,j}^{agri}}} = \frac{1}{\sum_{j=1}^{49} e^{V_{Al,j}^{agri}}}$$

2 Because it is a fraction-based equation the last equation is redundant.

⇨ $$\sum_{j=1}^{49} e^{V_{Al,j}^{agri}} = \frac{1}{0.91195514\ 9}$$

⇨ $$\sum_{j=1}^{49} e^{V_{Al,j}^{agri}} = 1.09654515$$

Given $\sum_{j=1}^{49} e^{V_{Al,j}^{agri}}$ = 1.09654515, the relative utilities for flows from Alabama to the other attraction states can be calculated. These utilities are referred to as relative utilities, because the values are computed relative to the base utility (i.e., utility for agricultural production flows from Alabama to Alabama). For example, the relative utility for the fractional agricultural production flows from Alabama to Arizona can be computed as follows:

- $$0.00001 = \frac{e^{V_{Al,Ar}^{agri}}}{\sum_{j=1}^{49} e^{V_{Al,j}^{agri}}}$$
- $$0.00001 = \frac{e^{V_{Al,Ar}^{agri}}}{1.096545155}$$
- $$e^{V_{Al,Ar}^{agri}} = 1.096545155E-05$$

Applying the natural logarithm on both sides provide:

- $$V_{Al,Ar}^{agri} = -11.420761$$

Thus, the relative utility for the fractional flows of agricultural commodities from Alabama to Arizona relative to the fractional agricultural production flows from Alabama to Alabama is equal to -11.42076. The relative utilities for the fractional commodity group production flows from Alabama to all the remaining attraction states are computed similarly (see screenshot on opposite page).

Calculation of Revised Fractional Flows

a. In column D, there are 40 cells with zero flows.

a. In column E, these zeros are replaced with 0.00001. Thus, 0.00040 needs to be deducted to ensure that the total fractional production flows sum to 1.

b. For simplicity, 0.00040 was deducted from the cell with the highest fractional flows (i.e., cell E2).

Calculation of Relative Utility Values

The formula used in Excel to calculate the relative utility values is: =LN(E3/$E$2).

Microsoft Excel - Step 3 Production Flow Distribu… …y Calcu.xls

F3 =LN(E3/$E$2)

	A	B	C	D	E	F	G	H	I
1	Origin State: Alabama		Agriculture	Fractional Flows	Revised Fractional Flows	Relative Utility	Food	Fractional Flows	Revised Fraction
2	AREA: Alabama	Tons(000)	5590	0.912355149	0.911955149	0	3600	0.623916811	0.6236268
3	AREA: Alaska	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
4	AREA: Arizona	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
5	AREA: Arkansas	Tons(000)	0	0	0.00001	-11.420761	87	0.01507799	0.0150779
6	AREA: California	Tons(000)	0	0	0.00001	-11.420761	90	0.01559792	0.0155979
7	AREA: Colorado	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
8	AREA: Connecticut	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
9	AREA: Delaware	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
10	AREA: District of Columbia	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
11	AREA: Florida	Tons(000)	109	0.017790109	0.017790109	-3.936948162	564	0.097746967	0.0977469
12	AREA: Georgia	Tons(000)	45	0.007344541	0.007344541	-4.821633554	411	0.071230503	0.0712305
13	AREA: Idaho	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
14	AREA: Illinois	Tons(000)	24	0.003917088	0.003917088	-5.450242214	92	0.015944541	0.0159445
15	AREA: Indiana	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
16	AREA: Iowa	Tons(000)	0	0	0.00001	-11.420761	24	0.004159445	0.0041594
17	AREA: Kansas	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
18	AREA: Kentucky	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
19	AREA: Louisiana	Tons(000)	0	0	0.00001	-11.420761	49	0.008492201	0.0084922
20	AREA: Maine	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
21	AREA: Maryland	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
22	AREA: Massachusetts	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
23	AREA: Michigan	Tons(000)	0	0	0.00001	-11.420761	63	0.010918544	0.0109185
24	AREA: Minnesota	Tons(000)	30	0.00489636	0.00489636	-5.227098663	0	0	0.00001
25	AREA: Mississippi	Tons(000)	0	0	0.00001	-11.420761	211	0.036568458	0.0365684
26	AREA: Missouri	Tons(000)	4	0.000652848	0.000652848	-7.242001683	40	0.006932409	0.0069324
27	AREA: Montana	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
28	AREA: Nebraska	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
29	AREA: Nevada	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
30	AREA: New Hampshire	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
31	AREA: New Jersey	Tons(000)	0	0	0.00001	-11.420761	15	0.002599653	0.0025996
32	AREA: New Mexico	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
33	AREA: New York	Tons(000)	0	0	0.00001	-11.420761	39	0.006759099	0.0067590
34	AREA: North Carolina	Tons(000)	49	0.007997389	0.007997389	-4.736475746	48	0.008318891	0.0083188
35	AREA: North Dakota	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
36	AREA: Ohio	Tons(000)	0	0	0.00001	-11.420761	55	0.009532062	0.0095320
37	AREA: Oklahoma	Tons(000)	10	0.00163212	0.00163212	-6.325710951	6	0.001039861	0.0010398
38	AREA: Oregon	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
39	AREA: Pennsylvania	Tons(000)	0	0	0.00001	-11.420761	31	0.005372617	0.0053726
40	AREA: Rhode Island	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
41	AREA: South Carolina	Tons(000)	0	0	0.00001	-11.420761	57	0.009878683	0.0098786
42	AREA: South Dakota	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
43	AREA: Tennessee	Tons(000)	222	0.036233067	0.036233067	-3.225618662	191	0.033102253	0.0331022
44	AREA: Texas	Tons(000)	44	0.007181329	0.007181329	-4.84410641	90	0.01559792	0.0155979
45	AREA: Utah	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
46	AREA: Vermont	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
47	AREA: Virginia	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
48	AREA: Washington	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
49	AREA: West Virginia	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
50	AREA: Wisconsin	Tons(000)	0	0	0.00001	-11.420761	7	0.001213172	0.0012131
51	AREA: Wyoming	Tons(000)	0	0	0.00001	-11.420761	0	0	0.00001
52									
53			**6127**	**1**	**1**	**-502.6402759**	**5770**	**1**	**1**
54									
55									

alabama / arizona / arkansas / california / colorado / connecticut / delaware / DOC / Flor

Step 3(b): Compute Utility Values for Attraction Flow Distribution Model

In the attraction flow distribution model, the utility values represent the propensity for flows to attraction state *j* from each of the production states *i*. From the definition of the MNL model, the fraction of the total attraction flows of commodity group *k* to attraction state *j* from production state *i* among *n* alternative production states can be expressed as follows:

$$FP_{ji}^{k} = \frac{e^{V_{ji}^{k}}}{\sum_{i=1}^{n} e^{V_{ji}^{k}}}$$

Where,

V_{ji}^{k} = Utility value for flows to state *j* from state *i* for commodity group *k*

During Step 3(b) the utility values for attraction flows to each attraction state from each production state for each commodity group is calculated. Agricultural attraction flows to Alabama from all other states are used to illustrate the computation of the utility values.

The steps required to compute the utility values are:

1. Examination of the fractional attraction flows calculated in Step 2(b) (See Column D in the Excel workbook Attraction Flow Distribution – Relative Utility Calcu on the CD) reveals that in a number of cases the agricultural attraction flows to Alabama from many of the production states are zero. If the attraction flows are zero, the utility value will be negative infinity and therefore undetermined (given the mathematical equation of the logit model). The fractional attraction flows therefore needs to be adjusted so the utility values can be computed for all flows to each attraction state from each production state.

   The utility values for zero flows can be approximated through a minor adjustment to the fractional flows. The adjustment involves replacing the zeros with a very small value (0.00001) to ensure that the computed utilities have a high negative value. Also, since the total fractional attraction flows to Alabama from all the production states have to equal 1, the added adjusted flows (= 0.00001 * Number of cells with zero flows) must be deducted from the flows in another cell(s) to ensure that the total fractional attraction flows sum to 1. For simplicity, the added adjusted flows were subtracted from the cell containing the highest fractional flows.

2. Once the revised fractional flows to Alabama from each production state are calculated, the utilities can be computed using the MNL equation on page x.

   a. The utility values for attraction flows to Alabama from each production state are the unknowns that need to be calculated. Thus, there are a total of 50 unknowns. Applying the MNL equation to attraction flows to Alabama from each production state results in 49 independent equations[3]. Thus, there are 49 independent equations and 50 unknowns to solve. This is addressed by assigning the utility value for flows to Alabama from an arbitrary production state *s* as zero and computing the utilities for attraction flows from the remaining states relative to the utility for flows from state *s.* The latter is referred to as the base utility since the utilities for flows to Alabama from all the other production states are relative to the utility for flows to Alabama from state *s*. Given the base utility value, there are 49 utility unknowns to be determined from 49 independent equations.

   b. In this example, the utility for agricultural attraction flows to Alabama from Alabama is assumed to be zero. The next step is to substitute the zero value and the revised fractional agricultural attraction flows in the MNL equation as follows:

$$0.89957 = \frac{e^0}{\sum_{i=1}^{49} e^{V_{Al,i}^{agri}}} = \frac{1}{\sum_{i=1}^{49} e^{V_{Al,i}^{agri}}}$$

[3] Because it is a fraction-based equation the last equation is redundant.

$$\sum_{i=1}^{49} e^{V_{Al,i}^{agri}} = 1.111642229$$

Given $\sum_{i=1}^{49} e^{V_{Al,i}^{agri}}$ = 1.111642229, the relative utilities for flows to Alabama from the other production states can be calculated. For example, the relative utility for the fractional agricultural attraction flows to Alabama from Arizona can be computed as follows:

$$0.00001 = \frac{e^{V_{Al,Ar}^{agri}}}{\sum_{i=1}^{49} e^{V_{Al,i}^{agri}}}$$

$$0.00001 = \frac{e^{V_{Al,Ar}^{agri}}}{1.111642229}$$

$$e^{V_{Al,Ar}^{agri}} = 1.111642229E - 05$$

Applying the natural logarithm on both sides provide:

$$V_{Al,Ar}^{agri} = -11.40708706$$

c. Thus, the relative utility for the fractional flows of agricultural commodities to Alabama from Arizona relative to the fractional agricultural attraction flows to Alabama from Alabama is equal to -11.40708706. The relative utilities for the fractional commodity group attraction flows to Alabama from all the remaining production states are computed similarly (see screenshot on opposite page).

Calculation of Revised Fractional Flows

a. In column D, there are 40 cells with zero flows.

c. In column E, these zeros are replaced with 0.00001. Thus, 0.00040 needs to be deducted to ensure that the total fractional attraction flows sum to 1.

d. For simplicity, 0.00040 was deducted from the cell with the highest fractional flows (i.e., cell E2).

Calculation of Relative Utility Values

The formula used in Excel to calculate the relative utility values is: =LN(E3/$E$2).

Microsoft Excel - Step 3 Attraction Flow Distribution ... cu.xls

F3 = -11.4070870573625

	A	B	C	D	E	F	G	H	I	J
1	**Destination State: Alabama**		**Agriculture**	**Fractional Flows**	**Revised Fractional Flows**	**Relative Utility**	**Food**	**ctional Flo**	**Fractiona**	**relative utili**
2	AREA: Alabama	Tons(000)	7728.75	0.8999738	0.89957	0	3600	0.568361	0.568101	0
3	AREA: Alaska	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
4	AREA: Arizona	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
5	AREA: Arkansas	Tons(000)	43	0.005007132	0.00501	-5.191053525	24	0.003789	0.003789	-5.01017773
6	AREA: California	Tons(000)	30	0.003493348	0.00349	-5.551056259	13	0.002052	0.002052	-5.62328220
7	AREA: Colorado	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
8	AREA: Connecticut	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
9	AREA: Delaware	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
10	AREA: District of Columbia	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
11	AREA: Florida	Tons(000)	223	0.025967221	0.02597	-3.545081869	168	0.026524	0.026524	-3.06426758
12	AREA: Georgia	Tons(000)	304	0.035399261	0.03540	-3.235225939	916	0.144616	0.144616	-1.36821519
13	AREA: Idaho	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
14	AREA: Illinois	Tons(000)	0	0	0.00001	-11.40708706	96	0.015156	0.015156	-3.62388337
15	AREA: Indiana	Tons(000)	17	0.001979564	0.00198	-6.119040297	38	0.005999	0.005999	-4.55064540
16	AREA: Iowa	Tons(000)	0	0	0.00001	-11.40708706	43	0.006789	0.006789	-4.42703144
17	AREA: Kansas	Tons(000)	0	0	0.00001	-11.40708706	40	0.006315	0.006315	-4.4993521
18	AREA: Kentucky	Tons(000)	36	0.004192018	0.00419	-5.368734702	20	0.003158	0.003158	-5.1924992
19	AREA: Louisiana	Tons(000)	0	0	0.00001	-11.40708706	20	0.003158	0.003158	-5.1924992
20	AREA: Maine	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
21	AREA: Maryland	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
22	AREA: Massachusetts	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
23	AREA: Michigan	Tons(000)	0	0	0.00001	-11.40708706	21	0.003315	0.003315	-5.14370912
24	AREA: Minnesota	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
25	AREA: Mississippi	Tons(000)	15	0.001746674	0.00175	-6.244203439	121	0.019103	0.019103	-3.39244101
26	AREA: Missouri	Tons(000)	0	0	0.00001	-11.40708706	10	0.001579	0.001579	-5.88564647
27	AREA: Montana	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
28	AREA: Nebraska	Tons(000)	0	0	0.00001	-11.40708706	39	0.006157	0.006157	-4.52466991
29	AREA: Nevada	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
30	AREA: New Hampshire	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
31	AREA: New Jersey	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
32	AREA: New Mexico	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
33	AREA: New York	Tons(000)	0	0	0.00001	-11.40708706	16	0.002526	0.002526	-5.41564284
34	AREA: North Carolina	Tons(000)	0	0	0.00001	-11.40708706	46	0.007262	0.007262	-4.35959016
35	AREA: North Dakota	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
36	AREA: Ohio	Tons(000)	0	0	0.00001	-11.40708706	35	0.005526	0.005526	-4.63288350
37	AREA: Oklahoma	Tons(000)	0	0	0.00001	-11.40708706	6	0.000947	0.000947	-6.39647209
38	AREA: Oregon	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
39	AREA: Pennsylvania	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
40	AREA: Rhode Island	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
41	AREA: South Carolina	Tons(000)	0	0	0.00001	-11.40708706	44	0.006947	0.006947	-4.4040419
42	AREA: South Dakota	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
43	AREA: Tennessee	Tons(000)	170	0.019795639	0.01980	-3.816455204	768	0.12125	0.12125	-1.54444183
44	AREA: Texas	Tons(000)	21	0.002445344	0.00245	-5.907731203	202	0.031891	0.031891	-2.87996386
45	AREA: Utah	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
46	AREA: Vermont	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
47	AREA: Virginia	Tons(000)	0	0	0.00001	-11.40708706	19	0.003	0.003	-5.24379258
48	AREA: Washington	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
49	AREA: West Virginia	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
50	AREA: Wisconsin	Tons(000)	0	0	0.00001	-11.40708706	29	0.004578	0.004578	-4.82093573
51	AREA: Wyoming	Tons(000)	0	0	0.00001	-11.40708706	0	0	0.00001	-10.9474698
52										
53			**8587.75**	**1**	**0.9999962**	**-501.2620647**	**6334**	**1**	**1**	**-385.830299**
54										
55										
56										
57										
58										

alabama / arizona / arkansas / california / colorado / connecticut / delaware / DOC / florida

Step 4: Develop State-to-State Centroidal Distance Matrix

State-to-state centroidal distances were calculated using the TransCAD GIS software as the shortest path distance along the highway network between state centroids. The procedure for calculating the inter-state centroidal distances is as follows:

- Create a TransCAD map with the U.S. state and highway layers.
- Connect the state centroids to the highway layer using *Centroid Connectors*[4] in the *Planning/Planning Utilities* feature of TransCAD.
- Create a highway network that includes the newly added nodes representing the state centroids. The new highway network is created by selecting the highway nodes representing state centroids and designating these nodes as centroids in the *Network Settings* feature of TransCAD.
- Compute the inter-state centroidal distances by calculating the shortest path distance along the highway network between state centroids. The output from TransCAD is a shortest path inter-state centroidal distance matrix.

In the absence of significant changes to the inter-state highway system, these centroidal distances (see State to State Centroidal Distances on the CD) can be used in future model calibrations.

[4] The highway network needs to be linked to the state centroids, because state centroids do not represent highway nodes.

Step 5: Conduct Linear Regression Analysis

Production Flow Distribution

For the production flow distribution model, utility equations need to be developed for commodity flows from production state *i* to the attraction states *j* as a function of a set of independent variables that impact the production flow distribution of commodities. The two independent variables considered in developing the utility equations are:

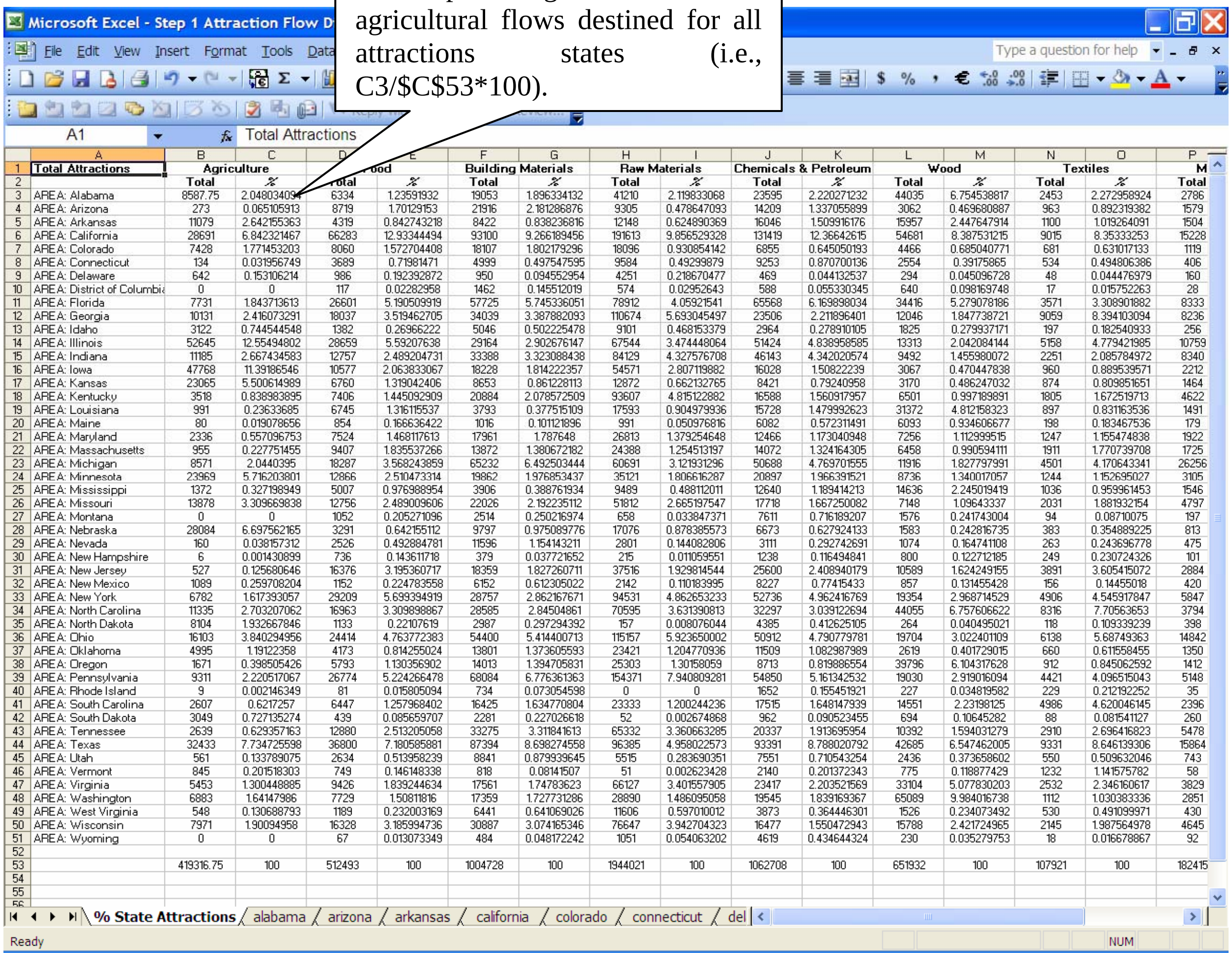
a) distance, which represents an impedance measure for commodity flows between states calculated in Step 4 (see the workbook State to State Centroidal Distances on the CD), and

b) the fractional attraction level of the attraction states calculated in the workbook Attraction Flow Distribution on the CD. The fractional attraction level of the attraction states is determined by calculating the flows of commodity group *k* destined for the attraction state *j* as a percentage of the total commodity *k* flows destined for all attraction states (see screenshot on opposite page).

In other words, the distribution of commodity flows from production state *i* to the attraction states *j* can be estimated considering the inter-state centroidal distances and the percentage of the commodity flows destined for the attraction state *j* of the total commodity flows destined for all attraction states (i.e., fractional attraction level of attraction states).

Fractional Attraction Level of Destination States

Total flows destined for Alabama as a percentage of the total agricultural flows destined for all attractions states (i.e., C3/$C$53*100).



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Total Attractions	Agriculture			ood	Building Materials		Raw Materials		Chemicals & Petroleum		Wood		Textiles		M
2		Total	%	otal	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total
3	AREA: Alabama	8587.75	2.04803409	6334	1.23591932	19053	1.896334132	41210	2.119833068	23595	2.220271232	44035	6.754538817	2453	2.272958924	2786
4	AREA: Arizona	273	0.065105913	8719	1.70129153	21916	2.181286876	9305	0.478647093	14209	1.337055899	3062	0.469680887	963	0.892319382	1579
5	AREA: Arkansas	11079	2.642155363	4319	0.842743218	8422	0.838236816	12148	0.624890369	16046	1.509916176	15957	2.447647914	1100	1.019264091	1504
6	AREA: California	28691	6.842321467	66283	12.93344494	93100	9.266189456	191613	9.856529328	131419	12.36642615	54681	8.387531215	9015	8.35333253	15228
7	AREA: Colorado	7428	1.771453203	8060	1.572704408	18107	1.802179296	18096	0.930854142	6855	0.645050193	4466	0.685040771	681	0.631017133	1119
8	AREA: Connecticut	134	0.031956749	3689	0.71981471	4999	0.497547595	9584	0.49299879	9253	0.870700136	2554	0.39175865	534	0.494806386	406
9	AREA: Delaware	642	0.153106214	986	0.192392872	950	0.094552954	4251	0.218670477	469	0.044132537	294	0.045096728	48	0.044476979	160
10	AREA: District of Columbi	0	0	117	0.02282958	1462	0.145512019	574	0.02952643	588	0.055330345	640	0.098169748	17	0.015752263	28
11	AREA: Florida	7731	1.843713613	26601	5.190509919	57725	5.745336051	78912	4.05921541	65568	6.169898034	34416	5.279078186	3571	3.308901882	8333
12	AREA: Georgia	10131	2.416073291	18037	3.519462705	34039	3.387882093	110674	5.693045497	23506	2.211896401	12046	1.847738721	9059	8.394103094	8236
13	AREA: Idaho	3122	0.744544548	1382	0.26966222	5046	0.502225478	9101	0.468153379	2964	0.278910105	1825	0.279937171	197	0.182540933	256
14	AREA: Illinois	52645	12.55494802	28659	5.59207638	29164	2.902676147	67544	3.474448064	51424	4.838958585	13313	2.042084144	5158	4.779421985	10759
15	AREA: Indiana	11185	2.667434583	12757	2.489204731	33388	3.323088438	84129	4.327576708	46143	4.342020574	9492	1.455980072	2251	2.085784972	8340
16	AREA: Iowa	47768	11.39186546	10577	2.063833067	18228	1.814222357	54571	2.807119882	16028	1.50822239	3067	0.470447838	960	0.889539571	2212
17	AREA: Kansas	23065	5.500614989	6760	1.319042406	8653	0.861228113	12872	0.662132765	8421	0.79240958	3170	0.486247032	874	0.809851651	1464
18	AREA: Kentucky	3518	0.838983895	7406	1.445092909	20884	2.078572509	93607	4.815122882	16588	1.560917957	6501	0.997189891	1805	1.672519713	4622
19	AREA: Louisiana	991	0.23633685	6745	1.316115537	3793	0.377515109	17593	0.904979936	15728	1.479992623	31372	4.812158323	897	0.831163536	1491
20	AREA: Maine	80	0.019078656	854	0.166636422	1016	0.101121896	991	0.050976816	6082	0.572311491	6093	0.934606677	198	0.183467536	179
21	AREA: Maryland	2336	0.557096753	7524	1.468117613	17961	1.787648	26813	1.379254648	12466	1.173040948	7256	1.112999515	1247	1.155474838	1922
22	AREA: Massachusetts	955	0.227751455	9407	1.835537266	13872	1.380672182	24388	1.254513197	14072	1.324164305	6458	0.990594111	1911	1.770739708	1725
23	AREA: Michigan	8571	2.0440395	18287	3.568243859	65232	6.492503444	60691	3.121931296	50688	4.769701555	11916	1.827797991	4501	4.170643341	26256
24	AREA: Minnesota	23969	5.716203801	12866	2.510473314	19862	1.976853437	35121	1.806616287	20897	1.966391521	8736	1.340017057	1244	1.152695027	3105
25	AREA: Mississippi	1372	0.327198949	5007	0.976988954	3906	0.388761934	9489	0.488112011	12640	1.189414213	14636	2.245019419	1036	0.959961453	1546
26	AREA: Missouri	13878	3.309669838	12756	2.489009606	22026	2.192235112	51812	2.665197547	17718	1.667250082	7148	1.09643337	2031	1.881932154	4797
27	AREA: Montana	0	0	1052	0.205271096	2514	0.250216974	658	0.033847371	7611	0.716189207	1576	0.241743004	94	0.08710075	197
28	AREA: Nebraska	28084	6.697562165	3291	0.642155112	9797	0.975089776	17076	0.878385573	6673	0.627924133	1583	0.242816735	383	0.354889225	813
29	AREA: Nevada	160	0.038157312	2526	0.492884781	11596	1.154143211	2801	0.144082806	3111	0.292742691	1074	0.164741108	263	0.243696778	475
30	AREA: New Hampshire	6	0.001430899	736	0.143611718	379	0.037721652	215	0.011059551	1238	0.116494841	800	0.122712185	249	0.230724326	101
31	AREA: New Jersey	527	0.125680646	16376	3.195360717	18359	1.827260711	37516	1.929814544	25600	2.408940179	10589	1.624249155	3891	3.605415072	2884
32	AREA: New Mexico	1089	0.259708204	1152	0.224783558	6152	0.612305022	2142	0.110183995	8227	0.77415433	857	0.131455428	156	0.14455018	420
33	AREA: New York	6782	1.617393057	29209	5.699394919	28757	2.862167671	94531	4.862653233	52736	4.962416769	19354	2.968714529	4906	4.545917847	5847
34	AREA: North Carolina	11335	2.703207062	16963	3.309898867	28585	2.84504861	70595	3.631390813	32297	3.039122694	44055	6.757606622	8316	7.70563653	3794
35	AREA: North Dakota	8104	1.932667846	1133	0.22107619	2987	0.297294392	157	0.008076044	4385	0.412625105	264	0.040495021	118	0.109339239	398
36	AREA: Ohio	16103	3.840294956	24414	4.763772383	54400	5.414400713	115157	5.923650002	50912	4.790779781	19704	3.022401109	6138	5.68749363	14842
37	AREA: Oklahoma	4995	1.19122358	4173	0.814255024	13801	1.373605593	23421	1.204770936	11509	1.082987989	2619	0.401729015	660	0.611558455	1350
38	AREA: Oregon	1671	0.398505426	5793	1.130356902	14013	1.394705831	25303	1.30158059	8713	0.819886554	39796	6.104317628	912	0.845062592	1412
39	AREA: Pennsylvania	9311	2.220517067	26774	5.224266478	68084	6.776361363	154371	7.940809281	54850	5.161342532	19030	2.919016094	4421	4.096515043	5148
40	AREA: Rhode Island	9	0.002146349	81	0.015805094	734	0.073054598	0	0	1652	0.155451921	227	0.034819582	229	0.212192252	35
41	AREA: South Carolina	2607	0.6217257	6447	1.257968402	16425	1.634770804	23333	1.200244236	17515	1.648147939	14551	2.23198125	4986	4.620046145	2396
42	AREA: South Dakota	3049	0.727135274	439	0.085659707	2281	0.227026618	52	0.002674868	962	0.090523455	694	0.10645282	88	0.081541127	260
43	AREA: Tennessee	2639	0.629357163	12880	2.513205058	33275	3.311841613	65332	3.360663285	20337	1.913695954	10392	1.594031279	2910	2.696416823	5478
44	AREA: Texas	32433	7.734725598	36800	7.180585881	87394	8.698274558	96385	4.958022573	93391	8.788020792	42685	6.547462005	9331	8.646139306	15864
45	AREA: Utah	561	0.133789075	2634	0.513958239	8841	0.879939645	5515	0.283690351	7551	0.710543254	2436	0.373658602	550	0.509632046	743
46	AREA: Vermont	845	0.201518303	749	0.146148338	818	0.08141507	51	0.002623428	2140	0.201372343	775	0.118877429	1232	1.141575782	58
47	AREA: Virginia	5453	1.300448885	9426	1.839244634	17561	1.74783623	66127	3.401557905	23417	2.203521569	33104	5.077830203	2532	2.346160617	3829
48	AREA: Washington	6883	1.64147986	7729	1.50811816	17359	1.727731286	28890	1.486095058	19545	1.839169367	65089	9.984016738	1112	1.030383336	2851
49	AREA: West Virginia	548	0.130688793	1189	0.232003169	6441	0.641069026	11606	0.597010012	3873	0.364446301	1526	0.234073492	530	0.491099971	430
50	AREA: Wisconsin	7971	1.90094958	16328	3.185994736	30887	3.074165346	76647	3.942704323	16477	1.550472943	15788	2.421724965	2145	1.987564978	4645
51	AREA: Wyoming	0	0	67	0.013073349	484	0.048172242	1051	0.054063202	4619	0.434644324	230	0.035279753	18	0.016678867	92
52																
53		419316.75	100	512493	100	1004728	100	1944021	100	1062708	100	651932	100	107921	100	182415
54																
55																

To simplify the calibration of the production flow distribution model, it was assumed that the form of the utility function is linear. The utility functions for flows from production state *i* to the attraction states j are thus estimated by performing linear regression analysis of the dependent variable (i.e., calculated relative utilities) with the explanatory variables (i.e., distance and fractional attraction level). However, since the dependent variables in the linear regressions are the relative utilities, the independent variables have to be relative centroidal distances, and relative fractional attraction levels. The linear equation representing the relative utility as a function of the explanatory variables is thus:

$$V_{ij|s}^{k} = \alpha_0^k + \alpha_1^k d_{ij|s} + \alpha_2^k FA_{j|s}^{k}$$

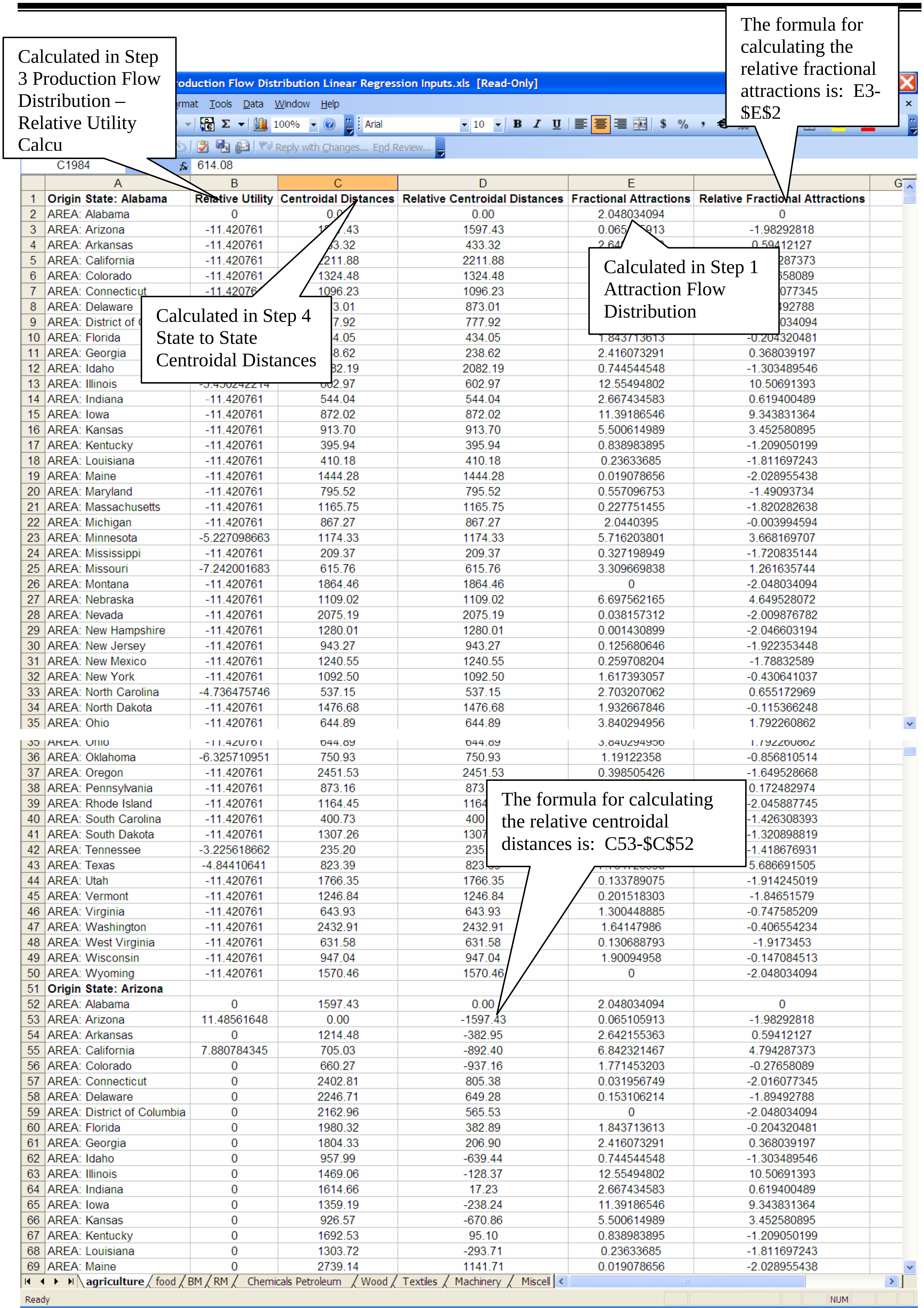
Where,

$V_{ij|s}^{k}$ = Utility for flows from state *i* to state *j* relative to flows from state *i* to state *s* (In this model, state *s* is Alabama)

$d_{ij|s}$ = d_{ij} - d_{is} = Relative centroidal distances, which is the distance between state *i* and state *j* relative to the distance between state *i* and state *s*

$FA_{j|s}^{k}$ = FA_j^k - FA_s^k = Relative fractional attraction level, which is the fractional attraction level of state *j* relative to the fractional attraction level of state *s*

The first step is thus to develop Excel worksheets that contain the relative utilities, the relative centroidal distances, and the relative fractional attraction levels (see the Production Flow Distribution Linear Regression Inputs workbook on the CD and the screenshot on the opposite page that illustrates the required calculations).



	A	B	C	D	E	F
1	Origin State: Alabama	Relative Utility	Centroidal Distances	Relative Centroidal Distances	Fractional Attractions	Relative Fractional Attractions
2	AREA: Alabama	0	[illegible]	0.00	2.048034094	0
3	AREA: Arizona	-11.420761	[illegible]	1597.43	[illegible]	-1.98292818
4	AREA: Arkansas	-11.420761	[illegible]	433.32	[illegible]	0.59412127
5	AREA: California	-11.420761	[illegible]	2211.88	[illegible]	[illegible]
6	AREA: Colorado	-11.420761	1324.48	1324.48	[illegible]	[illegible]
7	AREA: Connecticut	[illegible]	1096.23	1096.23	[illegible]	[illegible]
8	AREA: Delaware	[illegible]	[illegible]	873.01	[illegible]	[illegible]
9	AREA: District of [illegible]	[illegible]	[illegible]	777.92	[illegible]	[illegible]
10	AREA: Florida	[illegible]	[illegible]	434.05	[illegible]	-0.204320481
11	AREA: Georgia	[illegible]	[illegible]	238.62	2.416073291	0.368039197
12	AREA: Idaho	[illegible]	[illegible]	2082.19	0.744544548	-1.303489546
13	AREA: Illinois	[illegible]	[illegible]	602.97	12.55494802	10.50691393
14	AREA: Indiana	-11.420761	544.04	544.04	2.667434583	0.619400489
15	AREA: Iowa	-11.420761	872.02	872.02	11.39186546	9.343831364
16	AREA: Kansas	-11.420761	913.70	913.70	5.500614989	3.452580895
17	AREA: Kentucky	-11.420761	395.94	395.94	0.838983895	-1.209050199
18	AREA: Louisiana	-11.420761	410.18	410.18	0.23633685	-1.811697243
19	AREA: Maine	-11.420761	1444.28	1444.28	0.019078656	-2.028955438
20	AREA: Maryland	-11.420761	795.52	795.52	0.557096753	-1.49093734
21	AREA: Massachusetts	-11.420761	1165.75	1165.75	0.227751455	-1.820282638
22	AREA: Michigan	-11.420761	867.27	867.27	2.0440395	-0.003994594
23	AREA: Minnesota	-5.227098663	1174.33	1174.33	5.716203801	3.668169707
24	AREA: Mississippi	-11.420761	209.37	209.37	0.327198949	-1.720835144
25	AREA: Missouri	-7.242001683	615.76	615.76	3.309669838	1.261635744
26	AREA: Montana	-11.420761	1864.46	1864.46	0	-2.048034094
27	AREA: Nebraska	-11.420761	1109.02	1109.02	6.697562165	4.649528072
28	AREA: Nevada	-11.420761	2075.19	2075.19	0.038157312	-2.009876782
29	AREA: New Hampshire	-11.420761	1280.01	1280.01	0.001430899	-2.046603194
30	AREA: New Jersey	-11.420761	943.27	943.27	0.125680646	-1.922353448
31	AREA: New Mexico	-11.420761	1240.55	1240.55	0.259708204	-1.78832589
32	AREA: New York	-11.420761	1092.50	1092.50	1.617393057	-0.430641037
33	AREA: North Carolina	-4.736475746	537.15	537.15	2.703207062	0.655172969
34	AREA: North Dakota	-11.420761	1476.68	1476.68	1.932667846	-0.115366248
35	AREA: Ohio	-11.420761	644.89	644.89	3.840294956	1.792260862
36	AREA: Oklahoma	-6.325710951	750.93	750.93	1.19122358	-0.856810514
37	AREA: Oregon	-11.420761	2451.53	2451.53	0.398505426	-1.649528668
38	AREA: Pennsylvania	-11.420761	873.16	[illegible]	[illegible]	0.172482974
39	AREA: Rhode Island	-11.420761	1164.45	[illegible]	[illegible]	-2.045887745
40	AREA: South Carolina	-11.420761	400.73	[illegible]	[illegible]	-1.426308393
41	AREA: South Dakota	-11.420761	1307.26	[illegible]	[illegible]	-1.320898819
42	AREA: Tennessee	-3.225618662	235.20	[illegible]	[illegible]	-1.418676931
43	AREA: Texas	-4.84410641	823.39	[illegible]	[illegible]	5.686691505
44	AREA: Utah	-11.420761	1766.35	1766.35	0.133789075	-1.914245019
45	AREA: Vermont	-11.420761	1246.84	1246.84	0.201518303	-1.84651579
46	AREA: Virginia	-11.420761	643.93	643.93	1.300448885	-0.747585209
47	AREA: Washington	-11.420761	2432.91	2432.91	1.64147986	-0.406554234
48	AREA: West Virginia	-11.420761	631.58	631.58	0.130688793	-1.9173453
49	AREA: Wisconsin	-11.420761	947.04	947.04	1.90094958	-0.147084513
50	AREA: Wyoming	-11.420761	1570.46	1570.46	0	-2.048034094
51	Origin State: Arizona					
52	AREA: Alabama	0	1597.43	0.00	2.048034094	0
53	AREA: Arizona	11.48561648	0.00	-1597.43	0.065105913	-1.98292818
54	AREA: Arkansas	0	1214.48	-382.95	2.642155363	0.59412127
55	AREA: California	7.880784345	705.03	-892.40	6.842321467	4.794287373
56	AREA: Colorado	0	660.27	-937.16	1.771453203	-0.27658089
57	AREA: Connecticut	0	2402.81	805.38	0.031956749	-2.016077345
58	AREA: Delaware	0	2246.71	649.28	0.153106214	-1.89492788
59	AREA: District of Columbia	0	2162.96	565.53	0	-2.048034094
60	AREA: Florida	0	1980.32	382.89	1.843713613	-0.204320481
61	AREA: Georgia	0	1804.33	206.90	2.416073291	0.368039197
62	AREA: Idaho	0	957.99	-639.44	0.744544548	-1.303489546
63	AREA: Illinois	0	1469.06	-128.37	12.55494802	10.50691393
64	AREA: Indiana	0	1614.66	17.23	2.667434583	0.619400489
65	AREA: Iowa	0	1359.19	-238.24	11.39186546	9.343831364
66	AREA: Kansas	0	926.57	-670.86	5.500614989	3.452580895
67	AREA: Kentucky	0	1692.53	95.10	0.838983895	-1.209050199
68	AREA: Louisiana	0	1303.72	-293.71	0.23633685	-1.811697243
69	AREA: Maine	0	2739.14	1141.71	0.019078656	-2.028955438

Finally, 49 dummy variables were included to account for the presence of commodity flows between production state *i* and each of the attraction states *j*. A generalized form of the utility function for performing the regression analysis is thus:

$$V_{ij|s}^{k} = \alpha_0^k + \alpha_{01}^k X_{01} + \alpha_{02}^k X_{02} + ... + \alpha_{049}^k X_{049} + \alpha_1^k d_{ij|s} + \alpha_2^k FA_{j|s}^k$$

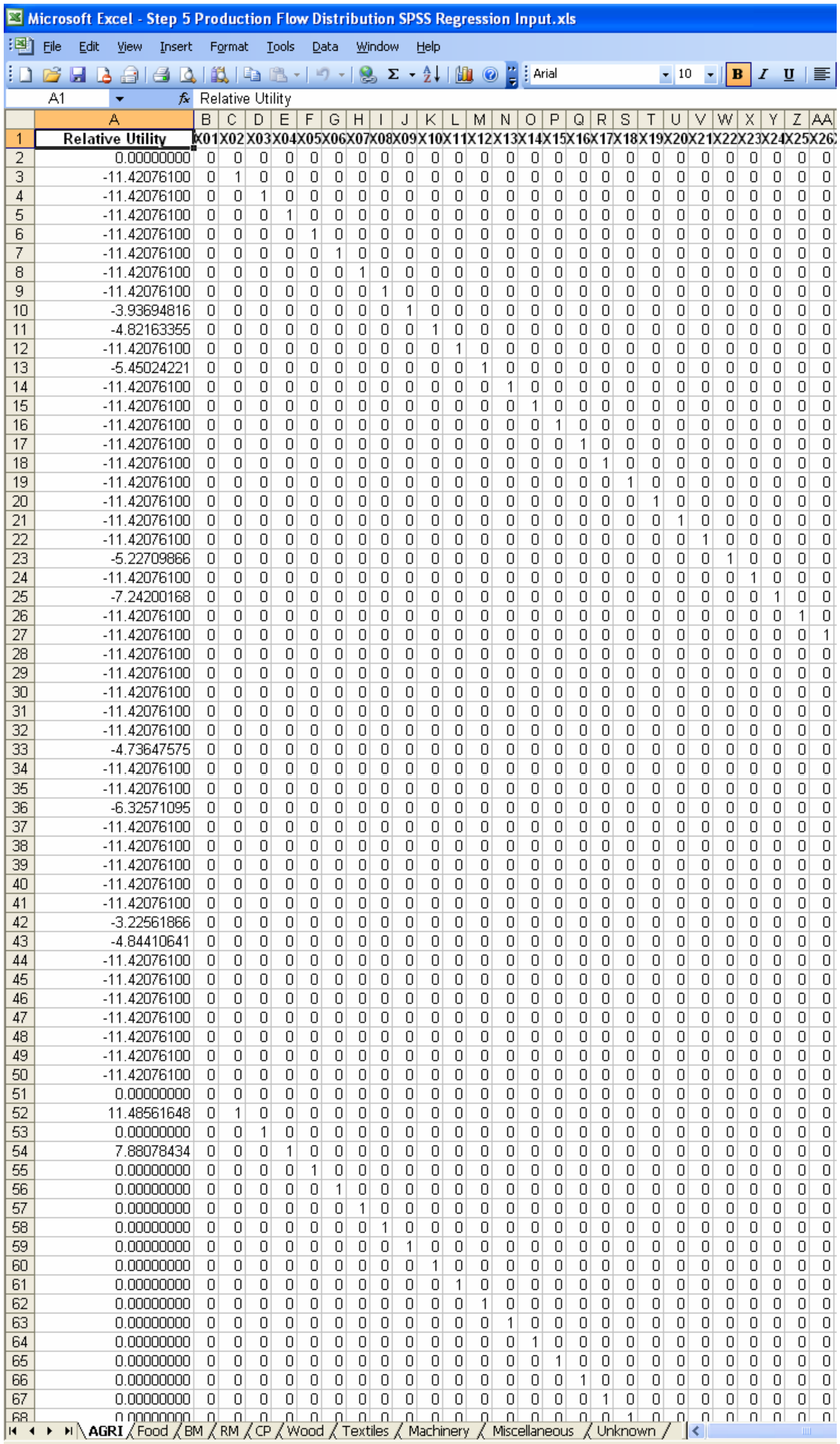
Where,

X_{0n}, n = 1, 2, …, 49 = Dummy variables with values:

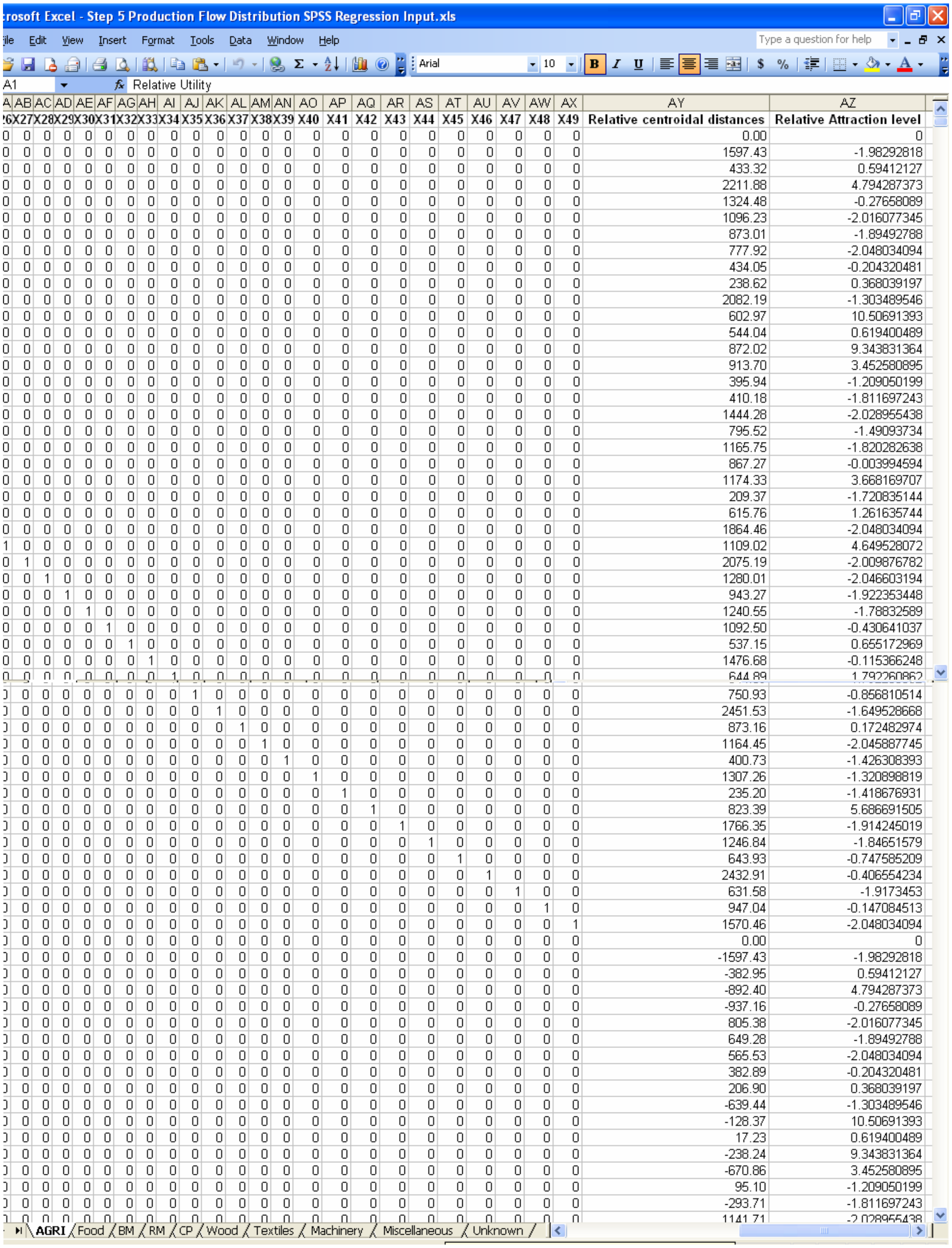
X_{0n} = 1 if j = *attraction state*

X_{0n} = 0 if $j \neq$ *attraction state*

Using this utility function, a regression of the relative utilities on the dummy variables, relative centroidal distances, and the relative fractional attraction levels can be run in a single step. Because of the number of independent variables (more than 15), Excel cannot be used to run the linear regression. Therefore SPSS, a statistical program, is recommended. The following two screenshots illustrate how the dummy variables were inserted in the Excel spreadsheet and how the worksheet needs to be formatted for performing the linear regression in SPSS (see also Production Flow Distribution SPSS Regression Input on the CD).



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA
1	Relative Utility	X01	X02	X03	X04	X05	X06	X07	X08	X09	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23	X24	X25	X26
2	0.00000000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	-11.42076100	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	-11.42076100	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	-11.42076100	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	-11.42076100	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	-11.42076100	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	-11.42076100	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	-11.42076100	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	-3.93694816	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	-4.82163355	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	-11.42076100	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	-5.45024221	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
15	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
16	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
17	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
18	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
19	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
20	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
21	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
22	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
23	-5.22709866	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
24	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
25	-7.24200168	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
26	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
27	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
28	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	-4.73647575	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	-6.32571095	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	-3.22561866	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	-4.84410641	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	-11.42076100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	0.00000000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	11.48561648	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	0.00000000	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	7.88078434	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	0.00000000	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0.00000000	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	0.00000000	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	0.00000000	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	0.00000000	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0.00000000	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	0.00000000	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0.00000000	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	0.00000000	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0.00000000	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
65	0.00000000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
66	0.00000000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
67	0.00000000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
68	0.00000000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0



6	X27	X28	X29	X30	X31	X32	X33	X34	X35	X36	X37	X38	X39	X40	X41	X42	X43	X44	X45	X46	X47	X48	X49	Relative centroidal distances	Relative Attraction level
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1597.43	-1.98292818
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	433.32	0.59412127
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2211.88	4.794287373
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1324.48	-0.27658089
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1096.23	-2.016077345
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	873.01	-1.89492788
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	777.92	-2.048034094
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	434.05	-0.204320481
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	238.62	0.368039197
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2082.19	-1.303489546
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	602.97	10.50691393
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	544.04	0.619400489
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	872.02	9.343831364
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	913.70	3.452580895
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	395.94	-1.209050199
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	410.18	-1.811697243
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1444.28	-2.028955438
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	795.52	-1.49093734
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1165.75	-1.820282638
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	867.27	-0.003994594
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1174.33	3.668169707
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	209.37	-1.720835144
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	615.76	1.261635744
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1864.46	-2.048034094
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1109.02	4.649528072
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2075.19	-2.009876782
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1280.01	-2.046603194
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	943.27	-1.922353448
0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1240.55	-1.78832589
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1092.50	-0.430641037
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	537.15	0.655172969
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1476.68	-0.115366248
0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	644.89	1.792260862
0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	750.93	-0.856810514
0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2451.53	-1.649528668
0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	873.16	0.172482974
0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1164.45	-2.045887745
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	400.73	-1.426308393
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1307.26	-1.320898819
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	235.20	-1.418676931
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	823.39	5.686691505
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1766.35	-1.914245019
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1246.84	-1.84651579
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	643.93	-0.747585209
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2432.91	-0.406554234
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	631.58	-1.9173453
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	947.04	-0.147084513
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1570.46	-2.048034094
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1597.43	-1.98292818
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-382.95	0.59412127
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-892.40	4.794287373
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-937.16	-0.27658089
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	805.38	-2.016077345
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	649.28	-1.89492788
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	565.53	-2.048034094
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	382.89	-0.204320481
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	206.90	0.368039197
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-639.44	-1.303489546
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-128.37	10.50691393
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17.23	0.619400489
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-238.24	9.343831364
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-670.86	3.452580895
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	95.10	-1.209050199
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-293.71	-1.811697243
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1141.71	-2.028955438

The next step is to import the Excel spreadsheet for each of the commodity groups into SPSS and to perform the linear regression analysis for each commodity group as follows:

- Open SPSS:
  - Click File - Open - Data and open one of the commodity group Excel worksheets
  - Click Analyze - Regression - Linear
  - Select "Relative Utilities" as the dependent variable
  - Select all the remaining variables as the independent variables
  - Click OK to perform the linear regression and to estimate the coefficients of the utility functions

  The outputs of the regression analysis are the Ordinary Least Square (OLS) estimates of the coefficients: $\hat{\alpha}_0^k$, $\hat{\alpha}_{0n}^k$ (whereas n = 1, 2…49), $\hat{\alpha}_1^k$ and $\hat{\alpha}_2^k$.

- Conduct significance testing of the coefficient estimates to test which of the coefficients are statistically significant.
  - The Student's t-test is used to conduct the significance testing. The regression output provides the "t" values for each explanatory variable. Specifying, a 90% confidence level, the critical t-statistic equals 1.696. All the independent variables with "t" values less than 1.696 are thus considered statistically insignificant at a 90% confidence level and are consequently rejected.
- Delete the statistically insignificant independent variables and perform linear regression analysis on the remaining variables. However, it is advised that the rejected variables are deleted one-by-one to ensure that variables that may be statistically significant are not deleted.
- Repeat these regressions until all the variables are statistically significant.

The final output of the OLS regression analysis for the utility functions of the production flow distribution model for truck flows from production state *i* to attraction state *j* by commodity is summarized on the next page.

Table 2: Outputs of the OLS Regression Analysis for the Production Flow Distribution Model

Commodity Category	Significant Variables	OLS Coefficient Estimates	Standard Error	t-statistic
Agriculture (k = 1)	Constant	1.504	0.560	2.6857
	d_{iT}	-0.003	0.000105	-28.479
Food (k = 2)	d_{iT}	-0.004	9.8643E-05	-40.550
	FA_T^2	0.605	0.030	20.098
Building Materials (k = 3)	Constant	-1.597	0.510	-3.130
	d_{iT}	-0.003	7.516E-05	-39.913
	FA_T^3	0.557	0.040	13.847
Raw Materials (k = 4)	Constant	1.117	0.448	2.496
	d_{iT}	-0.002	7.8E-05	-25.626
	FA_T^4	0.175	0.030	5.796
Chemicals and Petroleum (k = 5)	d_{iT}	-0.003	7.85E-05	-38.191
	FA_T^5	0.444	0.026	16.995
Wood (k = 6)	Constant	3.502	0.500	7.008
	d_{iT}	-0.004	9.23E-05	-43.307
	FA_T^6	0.165	0.053	3.104
Textiles (k = 7)	d_{iT}	-0.003	9.56E-05	-31.368
	FA_T^7	0.720	0.040	17.955
Machinery (k = 8)	Constant	1.062	0.462	2.299
	d_{iT}	-0.003	9.798E-05	-30.617
	FA_T^8	0.260	0.028	9.386
Miscellaneous (k = 9)	d_{iT}	-0.003	0.0001	-29.987
	FA_T^9	0.128	0.025	5.113

Attraction Flow Distribution

For the attraction flow distribution model, utility equations need to be developed for commodity flows to attraction state *j* from each of the production states *i* as a function of a set of independent variables that impact the attraction flow distribution of commodities. The two independent variables considered in developing the utility equations are:

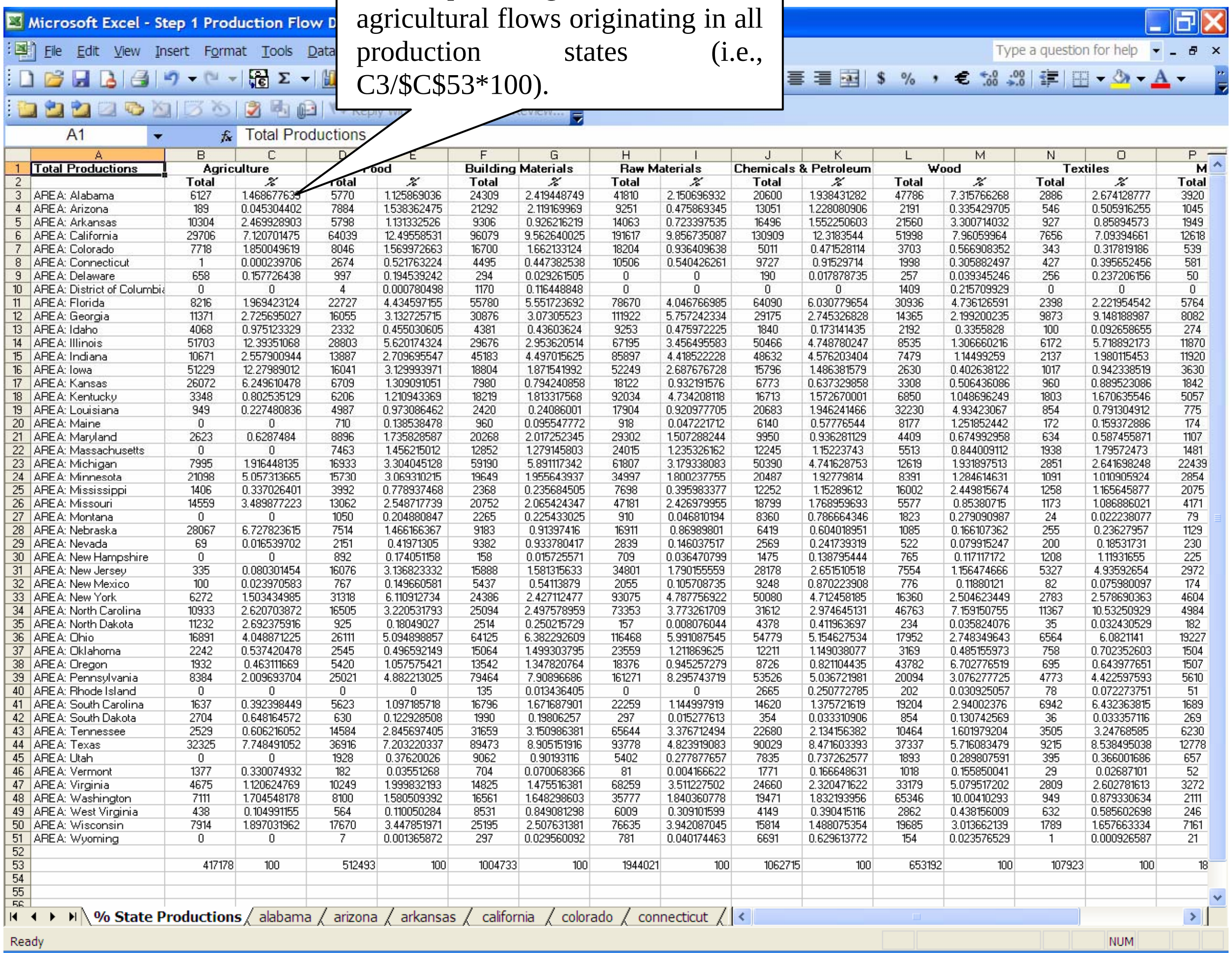
a) distance, which represents an impedance measure for commodity flows between states calculated in Step 4 (see the workbook State to State Centroidal Distances on the CD), and

b) the fractional production level of the production states calculated in the workbook Production Flow Distribution on the CD. The fractional production level of the production states is determined by calculating the flows of commodity group *k* originating in production state *i* as a percentage of the total commodity *k* flows originating in all production states (see screenshot on opposite page).

In other words, the distribution of commodity flows to attraction state *j* from the production states *i* can be estimated considering the inter-state centroidal distances and the percentage of the commodity flows originating from production state *i* as a percentage of the total commodity flows originating in all production states (i.e., fractional production level of production states).

Fractional Production Level of Origin States

Total flows originating in Alabama as a percentage of the total agricultural flows originating in all production states (i.e., C3/$C$53*100).



	Total Productions	Agriculture		Food		Building Materials		Raw Materials		Chemicals & Petroleum		Wood		Textiles		M
2		Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total
3	AREA: Alabama	6127	1.468677635	5770	1.125869036	24309	2.419448749	41810	2.150696932	20600	1.938431282	47786	7.315766268	2886	2.674128777	3920
4	AREA: Arizona	189	0.045304402	7884	1.538362475	21292	2.119169969	9251	0.475869345	13051	1.228080906	2191	0.335429705	546	0.505916255	1045
5	AREA: Arkansas	10304	2.469928903	5798	1.131332526	9306	0.926216219	14063	0.723397535	16496	1.552250603	21560	3.300714032	927	0.85894573	1949
6	AREA: California	29706	7.120701475	64039	12.49558531	96079	9.562640025	191617	9.856735087	130909	12.3183544	51998	7.96059964	7656	7.09394661	12618
7	AREA: Colorado	7718	1.850049619	8046	1.569972663	16700	1.662133124	18204	0.936409638	5011	0.471528114	3703	0.566908352	343	0.317819186	539
8	AREA: Connecticut	1	0.000239706	2674	0.521763224	4495	0.447382538	10506	0.540426261	9727	0.91529714	1998	0.305882497	427	0.395652456	581
9	AREA: Delaware	658	0.157726438	997	0.194539242	294	0.029261505	0	0	190	0.017878735	257	0.039345246	256	0.237206156	50
10	AREA: District of Columbia	0	0	4	0.000780498	1170	0.116448848	0	0	0	0	1409	0.215709929	0	0	0
11	AREA: Florida	8216	1.969423124	22727	4.434597155	55780	5.551723692	78670	4.046766985	64090	6.030779654	30936	4.736126591	2398	2.221954542	5764
12	AREA: Georgia	11371	2.725695027	16055	3.132725715	30876	3.07305523	111922	5.757242334	29175	2.745326828	14365	2.199200235	9873	9.148188987	8082
13	AREA: Idaho	4068	0.975123329	2332	0.455030605	4381	0.43603624	9253	0.475972225	1840	0.173141435	2192	0.3355828	100	0.092658655	274
14	AREA: Illinois	51703	12.39351068	28803	5.620174324	29676	2.953620514	67195	3.456495583	50466	4.748780247	8535	1.306660216	6172	5.718892173	11870
15	AREA: Indiana	10671	2.557900944	13887	2.709695547	45183	4.497015625	85897	4.418522228	48632	4.576203404	7479	1.14499259	2137	1.980115453	11920
16	AREA: Iowa	51229	12.27989012	16041	3.129993971	18804	1.871541992	52249	2.687676728	15796	1.486381579	2630	0.402638122	1017	0.942338519	3630
17	AREA: Kansas	26072	6.249610478	6709	1.309091051	7980	0.794240858	18122	0.932191576	6773	0.637329858	3308	0.506436086	960	0.889523086	1842
18	AREA: Kentucky	3348	0.802535129	6206	1.210943369	18219	1.813317568	92034	4.734208118	16713	1.572670001	6850	1.048696249	1803	1.670635546	5057
19	AREA: Louisiana	949	0.227480836	4987	0.973086462	2420	0.24086001	17904	0.920977705	20683	1.946241466	32230	4.93423067	854	0.791304912	775
20	AREA: Maine	0	0	710	0.138538478	960	0.095547772	918	0.047221712	6140	0.57776544	8177	1.251852442	172	0.159372886	174
21	AREA: Maryland	2623	0.6287484	8896	1.735828587	20268	2.017252345	29302	1.507288244	9950	0.936281129	4409	0.674992958	634	0.587455871	1107
22	AREA: Massachusetts	0	0	7463	1.456215012	12852	1.279145803	24015	1.235326162	12245	1.15223743	5513	0.844009112	1938	1.79572473	1481
23	AREA: Michigan	7995	1.916448135	16933	3.304045128	59190	5.891117342	61807	3.179338083	50390	4.741628753	12619	1.931897513	2851	2.641698248	22439
24	AREA: Minnesota	21098	5.057313665	15730	3.069310215	19649	1.955643937	34997	1.800237755	20487	1.92779814	8391	1.284614631	1091	1.010905924	2854
25	AREA: Mississippi	1406	0.337026401	3992	0.778937468	2368	0.235684505	7698	0.395983377	12252	1.15289612	16002	2.449815674	1258	1.165645877	2075
26	AREA: Missouri	14559	3.489877223	13062	2.548717739	20752	2.065424347	47181	2.426979955	18799	1.768959693	5577	0.85380715	1173	1.086886021	4171
27	AREA: Montana	0	0	1050	0.204880847	2265	0.225433025	910	0.046810194	8360	0.786664346	1823	0.279090987	24	0.022238077	79
28	AREA: Nebraska	28067	6.727823615	7514	1.466166367	9183	0.91397416	16911	0.86989801	6419	0.604018951	1085	0.166107362	255	0.23627957	1129
29	AREA: Nevada	69	0.016539702	2151	0.41971305	9382	0.933780417	2839	0.146037517	2569	0.241739319	522	0.079915247	200	0.18531731	230
30	AREA: New Hampshire	0	0	892	0.174051158	158	0.015725571	709	0.036470799	1475	0.138795444	765	0.117117172	1208	1.11931655	225
31	AREA: New Jersey	335	0.080301454	16076	3.136823332	15888	1.581315633	34801	1.790155559	28178	2.651510518	7554	1.156474666	5327	4.93592654	2972
32	AREA: New Mexico	100	0.023970583	767	0.149660581	5437	0.54113879	2055	0.105708735	9248	0.870223908	776	0.11880121	82	0.075980097	174
33	AREA: New York	6272	1.503434985	31318	6.110912734	24386	2.427112477	93075	4.787756922	50080	4.712458185	16360	2.504623449	2783	2.578690363	4604
34	AREA: North Carolina	10933	2.620703872	16505	3.220531793	25094	2.497578959	73353	3.773261709	31612	2.974645131	46763	7.159150755	11367	10.53250929	4984
35	AREA: North Dakota	11232	2.692375916	925	0.18049027	2514	0.250215729	157	0.008076044	4378	0.411963697	234	0.035824076	35	0.032430529	182
36	AREA: Ohio	16891	4.048871225	26111	5.094898857	64125	6.382292609	116468	5.991087545	54779	5.154627534	17952	2.748349643	6564	6.0821141	19227
37	AREA: Oklahoma	2242	0.537420478	2545	0.496592149	15064	1.499303795	23559	1.211869625	12211	1.149038077	3169	0.485155973	758	0.702352603	1504
38	AREA: Oregon	1932	0.463111669	5420	1.057575421	13542	1.347820764	18376	0.945257279	8726	0.821104435	43782	6.702776519	695	0.643977651	1507
39	AREA: Pennsylvania	8384	2.009693704	25021	4.882213025	79464	7.90896686	161271	8.295743719	53526	5.036721981	20094	3.076277725	4773	4.422597593	5610
40	AREA: Rhode Island	0	0	0	0	135	0.013436405	0	0	2665	0.250772785	202	0.030925057	78	0.072273751	51
41	AREA: South Carolina	1637	0.392398449	5623	1.097185718	16796	1.671687901	22259	1.144997919	14620	1.375721619	19204	2.94002376	6942	6.432363815	1689
42	AREA: South Dakota	2704	0.648164572	630	0.122928508	1990	0.19806257	297	0.015277613	354	0.033310906	854	0.130742569	36	0.033357116	269
43	AREA: Tennessee	2529	0.606216052	14584	2.845697405	31659	3.150986381	65644	3.376712494	22680	2.134156382	10464	1.601979204	3505	3.24768585	6230
44	AREA: Texas	32325	7.748491052	36916	7.203220337	89473	8.905151916	93778	4.823919083	90029	8.471603393	37337	5.716083479	9215	8.538495038	12778
45	AREA: Utah	0	0	1928	0.37620026	9062	0.90193116	5402	0.277877657	7835	0.737262577	1893	0.289807591	395	0.366001686	657
46	AREA: Vermont	1377	0.330074932	182	0.03551268	704	0.070068366	81	0.004166622	1771	0.166648631	1018	0.155850041	29	0.02687101	52
47	AREA: Virginia	4675	1.120624769	10249	1.999832193	14825	1.475516381	68259	3.511227502	24660	2.320471622	33179	5.079517202	2809	2.602781613	3272
48	AREA: Washington	7111	1.704548178	8100	1.580509392	16561	1.648298603	35777	1.840360778	19471	1.832193956	65346	10.00410293	949	0.879330634	2111
49	AREA: West Virginia	438	0.104991155	564	0.110050284	8531	0.849081298	6009	0.309101599	4149	0.390415116	2862	0.438156009	632	0.585602698	246
50	AREA: Wisconsin	7914	1.897031962	17670	3.447851971	25195	2.507631381	76635	3.942087045	15814	1.488075354	19685	3.013662139	1789	1.657663334	7161
51	AREA: Wyoming	0	0	7	0.001365872	297	0.029560092	781	0.040174463	6691	0.629613772	154	0.023576529	1	0.000926587	21
53		417178	100	512493	100	1004733	100	1944021	100	1062715	100	653192	100	107923	100	18

Similar to the calibration of the production flow distribution model, it was assumed that the form of the utility function is linear. The utility functions for flows to attraction state *j* from the production states *i* are thus estimated by performing linear regression analysis of the dependent variable (i.e., the calculated relative utilities) with the explanatory variables (i.e., distance and fractional production level). However, since the dependent variables in the linear regressions are the relative utilities, the independent variables have to be relative centroidal distances and relative fractional attraction levels. The linear equation representing the relative utility as a function of the explanatory variables is thus:

$$V_{ji|s}^{k} = \beta_0^k + \beta_1^k d_{ji|s} + \beta_2^k FP_{i|s}^k$$

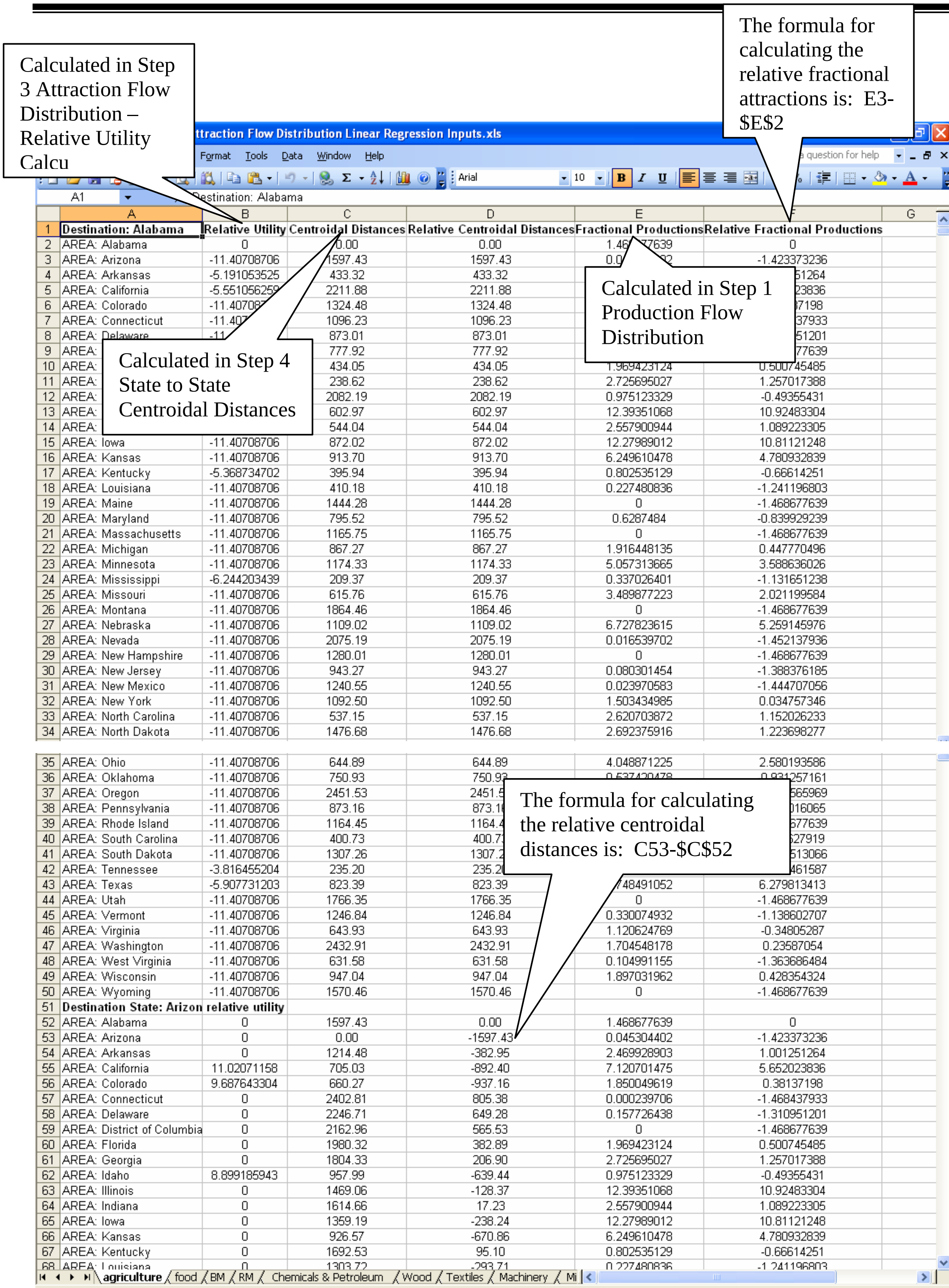
Where,

$V_{ji|s}^{k}$ = Utility for flows of commodity group *k* to attraction state *j* from production state *i* relative to flows from production state *s* to attraction state *j* (In this model, state *s* is Alabama)

$d_{ji|s}$ = d_{ji} - d_{js} = Relative centroidal distances, which is the distance between state *j* and state *i* relative to the distance between state *j* and state *s*

$FP_{i|s}^k$ = FP_i^k - FP_s^k = Relative fractional production level, which is the fractional production level of state *i* relative to the fractional production level of state *s*

The first step is thus to develop Excel worksheets for each commodity group that contain the relative utilities, the relative centroidal distances, and the relative fractional production levels (see the Attraction Flow Distribution Linear Regression Inputs workbook on the CD and the screenshot on the opposite page that illustrates the required calculations).



	A	B	C	D	E	F	G
1	**Destination: Alabama**	**Relative Utility**	**Centroidal Distances**	**Relative Centroidal Distances**	**Fractional Productions**	**Relative Fractional Productions**	
2	AREA: Alabama	0	0.00	0.00	1.46…77639	0	
3	AREA: Arizona	-11.40708706	1597.43	1597.43	0.0…2	-1.423373236	
4	AREA: Arkansas	-5.191053525	433.32	433.32	[illegible]	…51264	
5	AREA: California	-5.551056259	2211.88	2211.88	[illegible]	…23836	
6	AREA: Colorado	-11.40708…	1324.48	1324.48	[illegible]	…7198	
7	AREA: Connecticut	-11.407…	1096.23	1096.23	[illegible]	…37933	
8	AREA: Delaware	-11…	873.01	873.01	[illegible]	…51201	
9	AREA:	[illegible]	777.92	777.92	[illegible]	…77639	
10	AREA:	[illegible]	434.05	434.05	1.969423124	0.500745485	
11	AREA:	[illegible]	238.62	238.62	2.725695027	1.257017388	
12	AREA:	[illegible]	2082.19	2082.19	0.975123329	-0.49355431	
13	AREA:	[illegible]	602.97	602.97	12.39351068	10.92483304	
14	AREA:	[illegible]	544.04	544.04	2.557900944	1.089223305	
15	AREA: Iowa	-11.40708706	872.02	872.02	12.27989012	10.81121248	
16	AREA: Kansas	-11.40708706	913.70	913.70	6.249610478	4.780932839	
17	AREA: Kentucky	-5.368734702	395.94	395.94	0.802535129	-0.66614251	
18	AREA: Louisiana	-11.40708706	410.18	410.18	0.227480836	-1.241196803	
19	AREA: Maine	-11.40708706	1444.28	1444.28	0	-1.468677639	
20	AREA: Maryland	-11.40708706	795.52	795.52	0.6287484	-0.839929239	
21	AREA: Massachusetts	-11.40708706	1165.75	1165.75	0	-1.468677639	
22	AREA: Michigan	-11.40708706	867.27	867.27	1.916448135	0.447770496	
23	AREA: Minnesota	-11.40708706	1174.33	1174.33	5.057313665	3.588636026	
24	AREA: Mississippi	-6.244203439	209.37	209.37	0.337026401	-1.131651238	
25	AREA: Missouri	-11.40708706	615.76	615.76	3.489877223	2.021199584	
26	AREA: Montana	-11.40708706	1864.46	1864.46	0	-1.468677639	
27	AREA: Nebraska	-11.40708706	1109.02	1109.02	6.727823615	5.259145976	
28	AREA: Nevada	-11.40708706	2075.19	2075.19	0.016539702	-1.452137936	
29	AREA: New Hampshire	-11.40708706	1280.01	1280.01	0	-1.468677639	
30	AREA: New Jersey	-11.40708706	943.27	943.27	0.080301454	-1.388376185	
31	AREA: New Mexico	-11.40708706	1240.55	1240.55	0.023970583	-1.444707056	
32	AREA: New York	-11.40708706	1092.50	1092.50	1.503434985	0.034757346	
33	AREA: North Carolina	-11.40708706	537.15	537.15	2.620703872	1.152026233	
34	AREA: North Dakota	-11.40708706	1476.68	1476.68	2.692375916	1.223698277	
35	AREA: Ohio	-11.40708706	644.89	644.89	4.048871225	2.580193586	
36	AREA: Oklahoma	-11.40708706	750.93	750.93	[illegible]	[illegible]	
37	AREA: Oregon	-11.40708706	2451.53	2451.5…	[illegible]	…565969	
38	AREA: Pennsylvania	-11.40708706	873.16	873.1…	[illegible]	…016065	
39	AREA: Rhode Island	-11.40708706	1164.45	1164.4…	[illegible]	…677639	
40	AREA: South Carolina	-11.40708706	400.73	400.7…	[illegible]	…527919	
41	AREA: South Dakota	-11.40708706	1307.26	1307.2…	[illegible]	…513066	
42	AREA: Tennessee	-3.816455204	235.20	235.2…	[illegible]	…461587	
43	AREA: Texas	-5.907731203	823.39	823.39	…748491052	6.279813413	
44	AREA: Utah	-11.40708706	1766.35	1766.35	0	-1.468677639	
45	AREA: Vermont	-11.40708706	1246.84	1246.84	0.330074932	-1.138602707	
46	AREA: Virginia	-11.40708706	643.93	643.93	1.120624769	-0.34805287	
47	AREA: Washington	-11.40708706	2432.91	2432.91	1.704548178	0.23587054	
48	AREA: West Virginia	-11.40708706	631.58	631.58	0.104991155	-1.363686484	
49	AREA: Wisconsin	-11.40708706	947.04	947.04	1.897031962	0.428354324	
50	AREA: Wyoming	-11.40708706	1570.46	1570.46	0	-1.468677639	
51	**Destination State: Arizon**	**relative utility**					
52	AREA: Alabama	0	1597.43	0.00	1.468677639	0	
53	AREA: Arizona	0	0.00	-1597.43	0.045304402	-1.423373236	
54	AREA: Arkansas	0	1214.48	-382.95	2.469928903	1.001251264	
55	AREA: California	11.02071158	705.03	-892.40	7.120701475	5.652023836	
56	AREA: Colorado	9.687643304	660.27	-937.16	1.850049619	0.38137198	
57	AREA: Connecticut	0	2402.81	805.38	0.000239706	-1.468437933	
58	AREA: Delaware	0	2246.71	649.28	0.157726438	-1.310951201	
59	AREA: District of Columbia	0	2162.96	565.53	0	-1.468677639	
60	AREA: Florida	0	1980.32	382.89	1.969423124	0.500745485	
61	AREA: Georgia	0	1804.33	206.90	2.725695027	1.257017388	
62	AREA: Idaho	8.899185943	957.99	-639.44	0.975123329	-0.49355431	
63	AREA: Illinois	0	1469.06	-128.37	12.39351068	10.92483304	
64	AREA: Indiana	0	1614.66	17.23	2.557900944	1.089223305	
65	AREA: Iowa	0	1359.19	-238.24	12.27989012	10.81121248	
66	AREA: Kansas	0	926.57	-670.86	6.249610478	4.780932839	
67	AREA: Kentucky	0	1692.53	95.10	0.802535129	-0.66614251	
68	AREA: Louisiana	0	1303.72	-293.71	0.227480836	-1.241196803	

Finally, 49 dummy variables were included to account for the presence of commodity flows between attraction state *j* and each of the production states *i*. A generalized form of the utility function for performing the regression analysis is thus:

$$V_{ji|s}^{k} = \beta_0^k + \beta_{01}^k X_{01} + \beta_{02}^k X_{02} + ... + \beta_{049}^k X_{049} + \beta_1^k d_{ji|s} + \beta_2^k FP_{i|s}^k$$

Where

X_{0n}, n = 1, 2… 49 = Dummy variables with values:

X_{0n} = 1 if i = *production state*

X_{0n} = 0 if $i \neq$ *production state*

Using this utility function, a regression of the relative utilities on the dummy variables, relative centroidal distances, and the relative fractional production levels can be run in a single step. Because of the number of independent variables (more than 15), Excel cannot be used to run the linear regression. Therefore SPSS, a statistical program, is recommended. The following two screenshots illustrate how the dummy variables were inserted in the Excel spreadsheet and how the worksheet needs to be formatted for performing the linear regression in SPSS (see also Attraction Flow Distribution SPSS Regression Input on the CD).

Microsoft Excel - Step 5 Attraction Flow Distribution SPSS Regression Input.xls

A1 = Relative Utility

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN
1	**Relative Utility**	**X01**	**X02**	**X03**	**X04**	**X05**	**X06**	**X07**	**X08**	**X09**	**X10**	**X11**	**X12**	**X13**	**X14**	**X15**	**X16**	**X17**	**X18**	**X19**	**X20**	**X21**	**X22**	**X23**	**X24**	**X25**	**X26**	**X27**	**X28**	**X29**	**X30**	**X31**	**X32**	**X33**	**X34**	**X35**	**X36**	**X37**	**X38**	**X3**
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	-10.9474698	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	-5.010177734	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	-5.623282207	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	-10.9474698	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	-10.9474698	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	-10.9474698	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	-10.9474698	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	-3.064267585	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	-1.368215199	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	-10.9474698	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	-3.623883373	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	-4.550645404	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	-4.427031448	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	-4.49935211	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	-5.19249929	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	-5.19249929	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	-5.143709126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	-3.392441018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	-5.885646471	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	-4.524669918	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
28	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
29	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
30	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
31	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
32	-5.415642842	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
33	-4.359590167	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
34	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
35	-4.632883502	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
36	-6.396472095	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
37	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
38	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
39	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
37	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
38	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
39	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
40	-4.40404193	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
41	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	-1.544441831	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	-2.879963867	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	-5.243792585	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	-4.820935734	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	-10.9474698	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	**relative utility**																																							
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	11.32561097	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	6.58280036	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	9.139165974	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	5.966026158	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	6.289813235	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	5.330037391	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	5.147715835	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	5.435397907	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67	4.636890211	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	5.617719464	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
73	5.484188071	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74	4.519107175	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	5.806961464	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Sheets: AG / FOOD / BM / RM / CP / Wood / Textiles / MAchinery / Miscellaneous / Unknown rosoft Excel - Step 5 Attraction Flow Distribution SPSS Regression Input.xls

A1 — Relative Utility

Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ
X25	X26	X27	X28	X29	X30	X31	X32	X33	X34	X35	X36	X37	X38	X39	X40	X41	X42	X43	X44	X45	X46	X47	X48	X49	Relative centroidal distances	Relative Fractional Productions
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1597.43	0.412493439
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	433.32	0.005463489
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2211.88	11.36971627
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1324.48	0.444103627
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1096.23	-0.604105812
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	873.01	-0.931329794
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	777.92	-1.125088538
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	434.05	3.308728119
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	238.62	2.006856679
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2082.19	-0.670838431
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	602.97	4.494305288
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	544.04	1.583826511
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	872.02	2.004124934
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	913.70	0.183222015
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	395.94	0.085074333
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	410.18	-0.152782575
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1444.28	-0.987330559
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	795.52	0.609959551
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1165.75	0.330345975
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	867.27	2.178176092
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1174.33	1.943441179
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	209.37	-0.346931568
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	615.76	1.422848702
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1864.46	-0.920988189
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1109.02	0.340297331
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2075.19	-0.706155987
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1280.01	-0.951817878
0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	943.27	2.010954296
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1240.55	-0.976208456
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1092.50	4.985043698
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	537.15	2.094662756
0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1476.68	-0.945378766
0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	644.89	3.969029821
0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	750.93	-0.629276888
0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2451.53	-0.068293616
0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	873.16	3.756343989
0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2451.53	-0.068293616
0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	873.16	3.756343989
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1164.45	-1.125869036
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	400.73	-0.028683319
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1307.26	-1.002940528
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	235.20	1.719828368
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	823.39	6.0773513
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1766.35	-0.749668776
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1246.84	-1.090356356
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	643.93	0.873963157
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2432.91	0.454640356
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	631.58	-1.015818753
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	947.04	2.321982934
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1570.46	-1.124503164
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1597.43	0.412493439
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-382.95	0.005463489
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-892.40	11.36971627
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-937.16	0.444103627
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	805.38	-0.604105812
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	649.28	-0.931329794
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	565.53	-1.125088538
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	382.89	3.308728119
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	206.90	2.006856679
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-639.44	-0.670838431
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-128.37	4.494305288
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17.23	1.583826511
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-238.24	2.004124934
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-670.86	0.183222015
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	95.10	0.085074333
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-293.71	-0.152782575
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1141.71	-0.987330559
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	574.31	0.609959551
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	874.90	0.330345975
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	272.32	2.178176092
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16.22	1.943441179
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-178.26	-0.346931568
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-351.13	1.422848702

AG \ FOOD / BM / RM / CP / Wood / Textiles / MAchinery / Miscellaneous / Unknown /

The same procedure and steps for performing the linear regression analysis for the production flow distribution of commodities is required for the attraction flow distribution of commodities (see page 35 of the manual). The final output of the OLS regression analysis for the utility functions of the attraction flow distribution model for truck flows to attraction state j from production state i by commodity is summarized on the next page.

Table 3: Outputs of the OLS Regression Analysis for the Attraction Flow Distribution Model

Commodity Group	Significant Variables	OLS Coefficient Estimates	Standard Error	t-statistic
Agriculture (k = 1)	Constant	1.185	0.547	2.168
	d_{iT}	-0.002	8.9E-05	-22.467
	FP_T^1	0.126	0.028	4.414
Food (k = 2)	d_{iT}	-0.003	8.218E-05	-36.502
	FP_T^2	0.504	0.031	16.520
Building Materials (k = 3)	d_{iT}	-0.004	8.986E-05	-44.510
	FP_T^3	0.409	0.031	13.319
Raw Materials (k = 4)	d_{iT}	-0.002	8.857E-05	-22.580
	FP_T^4	0.104	0.028	3.649
Chemicals and Petroleum (k = 5)	d_{iT}	-0.003	8.603E-05	-34.871
	FP_T^5	0.371	0.028	13.205
Wood (k = 6)	Constant	1.060	0.457	2.319
	d_{iT}	-0.004	9.249E-05	-43.244
	FP_T^6	0.493	0.035	14.050
Textiles (k = 7)	d_{iT}	-0.003	9.203E-05	-32.598
	FP_T^7	0.431	0.033	13.167
Machinery (k = 8)	Constant	1.525	0.503	3.034
	d_{iT}	-0.003	8.185E-05	-36.650
	FP_T^8	0.096	0.041	2.360
Miscellaneous (k = 9)	d_{iT}	-0.003	0.000106	-28.300
	FP_T^9	0.168	0.025	6.685

Step 6: Compute Disaggregate Texas County Truck Flows

Step 6 requires the application of the calibrated MNL models to the state-level truck flows reported in the CFS to generate:

- Texas county-to-state truck flows (Internal-External),
- State-to-Texas county truck flows (External-Internal), and
- Texas county-to-county truck flows (Internal-Internal)

Step 6(a): Develop State-to-County and County-to-County Centroidal Distance Matrices

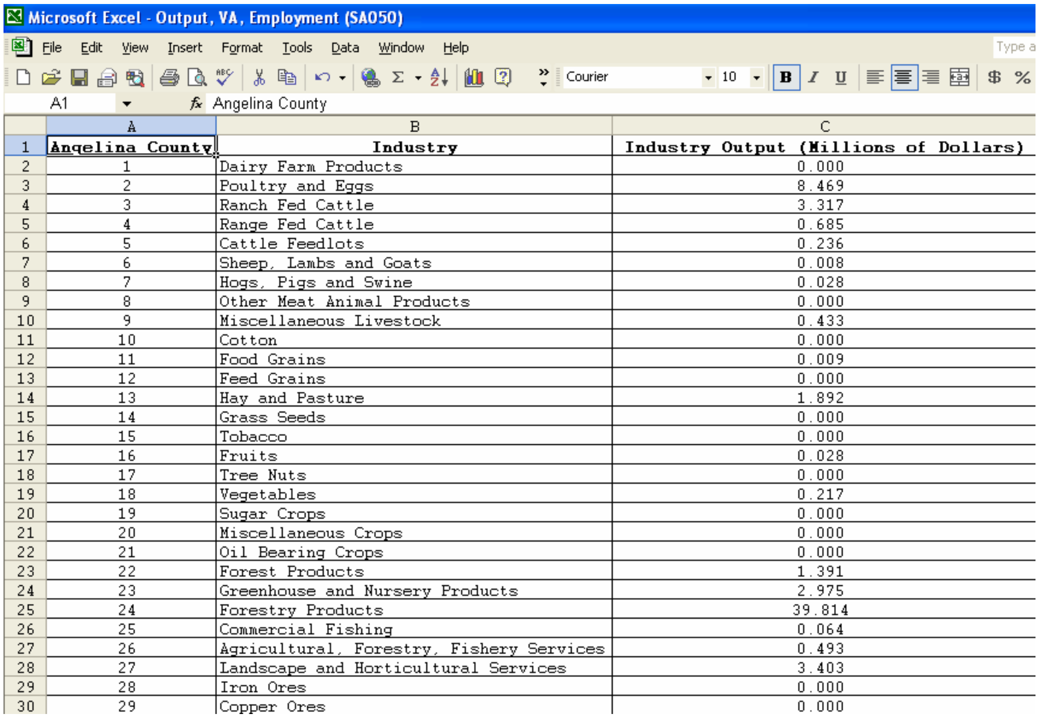
The first step in the computation of Texas county truck flows is the development of the state-to-county and county-to-county centroidal distance matrices. The procedure for calculating the state-to-county and county-to-county centroidal distances is the same as for the state-to-state centroidal distances (see page 27 of this manual). However, developing the state-to-county and county-to-county centroidal distance matrices requires a Texas county layer to be added to the U.S. State and highway layers on the map and the state and county centroids to be connected to the highway layer using the *centroid connectors* feature in TransCAD. A new highway network is then created to include the state and county centroids. The state-to-county and county-to-county centroidal distances are subsequently computed as the shortest path distance along the highway network (see County to State Centroidal Distances on the CD).

Step 6(b): Compute Texas County-to-State Truck Flows

Texas county-to-state truck flows for the nine commodity groups are estimated from the Texas-to-state truck flows reported in the CFS and the utility equations for the attraction flow distribution model developed in Step 5. In addition, disaggregating the Texas-to-state truck flows to generate Texas county-to-state truck flows using the calibrated attraction flow distribution model requires the fractional production level by each of the Texas counties of each commodity group.

Fractional Production Level of Texas Counties

The fractional production level of each commodity group originating in each of the Texas counties was calculated from the data captured in the IMPLAN database developed by the Minnesota IMPLAN Group (MIG) Inc. The IMPLAN database provides the industry output (millions of dollars) for a total of 528 industries for each county in Texas (for example, see opposite page for a screenshot of the industry output for Angelina County captured by IMPLAN). These 528 industries were grouped into the commodity groups listed in Table 1 on page 8 of the manual to compute the total commodity group output in millions of dollars for each of the Texas counties. The industry output for each Texas county for each commodity group was saved in an Excel file (see County Productions for each commodity group on the CD).



Angelina County	Industry	Industry Output (Millions of Dollars)
1	Dairy Farm Products	0.000
2	Poultry and Eggs	8.469
3	Ranch Fed Cattle	3.317
4	Range Fed Cattle	0.685
5	Cattle Feedlots	0.236
6	Sheep, Lambs and Goats	0.008
7	Hogs, Pigs and Swine	0.028
8	Other Meat Animal Products	0.000
9	Miscellaneous Livestock	0.433
10	Cotton	0.000
11	Food Grains	0.009
12	Feed Grains	0.000
13	Hay and Pasture	1.892
14	Grass Seeds	0.000
15	Tobacco	0.000
16	Fruits	0.028
17	Tree Nuts	0.000
18	Vegetables	0.217
19	Sugar Crops	0.000
20	Miscellaneous Crops	0.000
21	Oil Bearing Crops	0.000
22	Forest Products	1.391
23	Greenhouse and Nursery Products	2.975
24	Forestry Products	39.814
25	Commercial Fishing	0.064
26	Agricultural, Forestry, Fishery Services	0.493
27	Landscape and Horticultural Services	3.403
28	Iron Ores	0.000
29	Copper Ores	0.000

However, the county productions for each commodity group obtained from IMPLAN are in millions of dollars. Since the commodity tonnage produced are required, the value data were converted to tonnage by applying a value to weight factor for each commodity group that was calculated from the CFS data. The value to weight factors that were used are summarized in Table 4.

Table 4: Value to Weight Conversion Factors

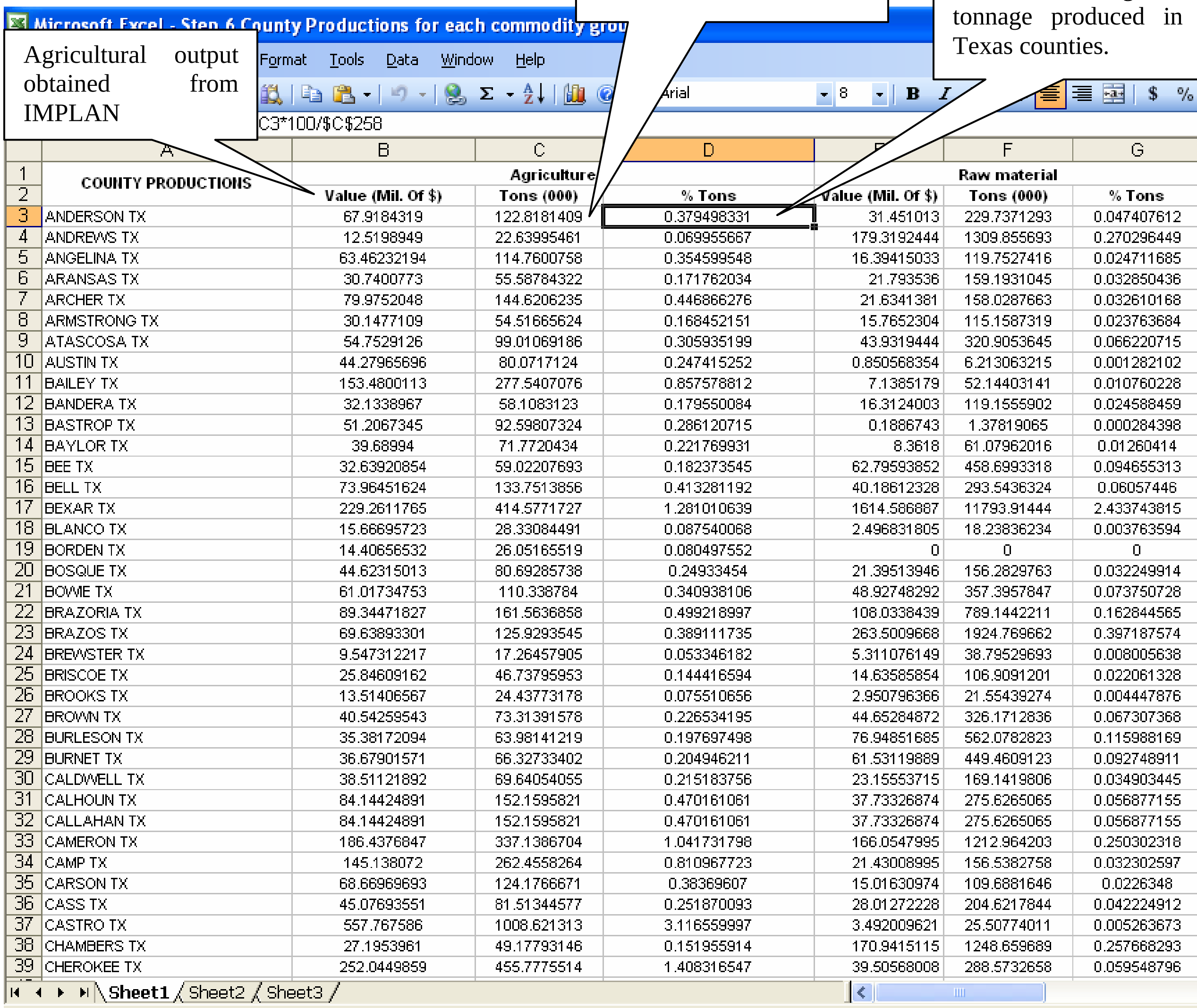
Commodity Group	Value:Weight ($ Million/1000 tons)
Agriculture	0.553
Food	5.4136
Building Materials	0.9453
Raw Materials	0.1369
Chemicals/Petroleum	5.62
Wood	1.9228
Textiles	6.48
Machinery	20.977
Miscellaneous	1.1731

Once the total commodity tonnage produced in each county are calculated, the fractional productions in each county for each commodity group can be determined. The Excel screenshot on the opposite page illustrates the required calculations for agricultural commodities.

The formula for calculating agricultural tonnage is: B3/0.553.

The formula for calculating the fractional productions is: C3*100/Total agricultural tonnage produced in all Texas counties.

Agricultural output obtained from IMPLAN



	A	B	C	D	E	F	G
1	COUNTY PRODUCTIONS		Agriculture			Raw material	
2		Value (Mil. Of $)	Tons (000)	% Tons	Value (Mil. Of $)	Tons (000)	% Tons
3	ANDERSON TX	67.9184319	122.8181409	0.379498331	31.451013	229.7371293	0.047407612
4	ANDREWS TX	12.5198949	22.63995461	0.069955667	179.3192444	1309.855693	0.270296449
5	ANGELINA TX	63.46232194	114.7600758	0.354599548	16.39415033	119.7527416	0.024711685
6	ARANSAS TX	30.7400773	55.58784322	0.171762034	21.793536	159.1931045	0.032850436
7	ARCHER TX	79.9752048	144.6206235	0.446866276	21.6341381	158.0287663	0.032610168
8	ARMSTRONG TX	30.1477109	54.51665624	0.168452151	15.7652304	115.1587319	0.023763684
9	ATASCOSA TX	54.7529126	99.01069186	0.305935199	43.9319444	320.9053645	0.066220715
10	AUSTIN TX	44.27965696	80.0717124	0.247415252	0.850568354	6.213063215	0.001282102
11	BAILEY TX	153.4800113	277.5407076	0.857578812	7.1385179	52.14403141	0.010760228
12	BANDERA TX	32.1338967	58.1083123	0.179550084	16.3124003	119.1555902	0.024588459
13	BASTROP TX	51.2067345	92.59807324	0.286120715	0.1886743	1.37819065	0.000284398
14	BAYLOR TX	39.68994	71.7720434	0.221769931	8.3618	61.07962016	0.01260414
15	BEE TX	32.63920854	59.02207693	0.182373545	62.79593852	458.6993318	0.094655313
16	BELL TX	73.96451624	133.7513856	0.413281192	40.18612328	293.5436324	0.06057446
17	BEXAR TX	229.2611765	414.5771727	1.281010639	1614.586887	11793.91444	2.433743815
18	BLANCO TX	15.66695723	28.33084491	0.087540068	2.496831805	18.23836234	0.003763594
19	BORDEN TX	14.40656532	26.05165519	0.080497552	0	0	0
20	BOSQUE TX	44.62315013	80.69285738	0.24933454	21.39513946	156.2829763	0.032249914
21	BOWIE TX	61.01734753	110.338784	0.340938106	48.92748292	357.3957847	0.073750728
22	BRAZORIA TX	89.34471827	161.5636858	0.499218997	108.0338439	789.1442211	0.162844565
23	BRAZOS TX	69.63893301	125.9293545	0.389111735	263.5009668	1924.769662	0.397187574
24	BREWSTER TX	9.547312217	17.26457905	0.053346182	5.311076149	38.79529693	0.008005638
25	BRISCOE TX	25.84609162	46.73795953	0.144416594	14.63585854	106.9091201	0.022061328
26	BROOKS TX	13.51406567	24.43773178	0.075510656	2.950796366	21.55439274	0.004447876
27	BROWN TX	40.54259543	73.31391578	0.226534195	44.65284872	326.1712836	0.067307368
28	BURLESON TX	35.38172094	63.98141219	0.197697498	76.94851685	562.0782823	0.115988169
29	BURNET TX	36.67901571	66.32733402	0.204946211	61.53119889	449.4609123	0.092748911
30	CALDWELL TX	38.51121892	69.64054055	0.215183756	23.15553715	169.1419806	0.034903445
31	CALHOUN TX	84.14424891	152.1595821	0.470161061	37.73326874	275.6265065	0.056877155
32	CALLAHAN TX	84.14424891	152.1595821	0.470161061	37.73326874	275.6265065	0.056877155
33	CAMERON TX	186.4376847	337.1386704	1.041731798	166.0547995	1212.964203	0.250302318
34	CAMP TX	145.138072	262.4558264	0.810967723	21.43008995	156.5382758	0.032302597
35	CARSON TX	68.66969693	124.1766671	0.38369607	15.01630974	109.6881646	0.0226348
36	CASS TX	45.07693551	81.51344577	0.251870093	28.01272228	204.6217844	0.042224912
37	CASTRO TX	557.767586	1008.621313	3.116559997	3.492009621	25.50774011	0.005263673
38	CHAMBERS TX	27.1953961	49.17793146	0.151955914	170.9415115	1248.659689	0.257668293
39	CHEROKEE TX	252.0449859	455.7775514	1.408316547	39.50568008	288.5732658	0.059548796

Once the fractional county productions of each commodity group and the state-to-county centroidal distances are available, then the utility equations of the calibrated attraction flow distribution model can be applied to compute Texas county-to-state flows. Agricultural truck flows to Alabama from Texas (available from CFS) is used to illustrate the procedure for computing Texas county-to-state truck flows. In essence, the objective is to determine the fraction of the total agricultural truck flows attracted to Alabama from Texas that originates in each Texas county.

The first step is to develop an Excel worksheet that contains the total annual agricultural truck flows to Alabama from Texas (available from CFS), the centroidal distances between Alabama and each of the Texas counties, and the fractional production of agricultural commodities by each Texas county (see Texas County to State Flows on the CD and the screenshot on the opposite page).

The utility equation for agricultural truck flows to Alabama from Texas developed in Step 5 is:

$$V_{Al,Tx}^{Agri} = 1.185 - (0.002 * d_{Al,Tx}) + (0.126 * FP_{Tx}^{Agri})$$

Where,

Tx = Texas is a production state

$d_{Al,Tx}$ = Centroidal distance between Alabama and Texas

FP_{Tx}^{Agri} = Fractional productions in Texas of agricultural commodities

The utility function for agricultural flows to Alabama from each Texas county is assumed to be the same as the utility function for agricultural flows to Alabama from Texas. Consequently, the utility function for agricultural flows to Alabama from county *i* in Texas is:

$$V_{Al,i}^{Agri} = 1.185 - (0.002 * d_{Al,i}) + (0.126 * FP_{i}^{Agri})$$

Where,

i = Texas county

$d_{Al,i}$ = Centroidal distance between Alabama and county i

FP_{i}^{Agri} = Fractional production of agricultural commodities in county i

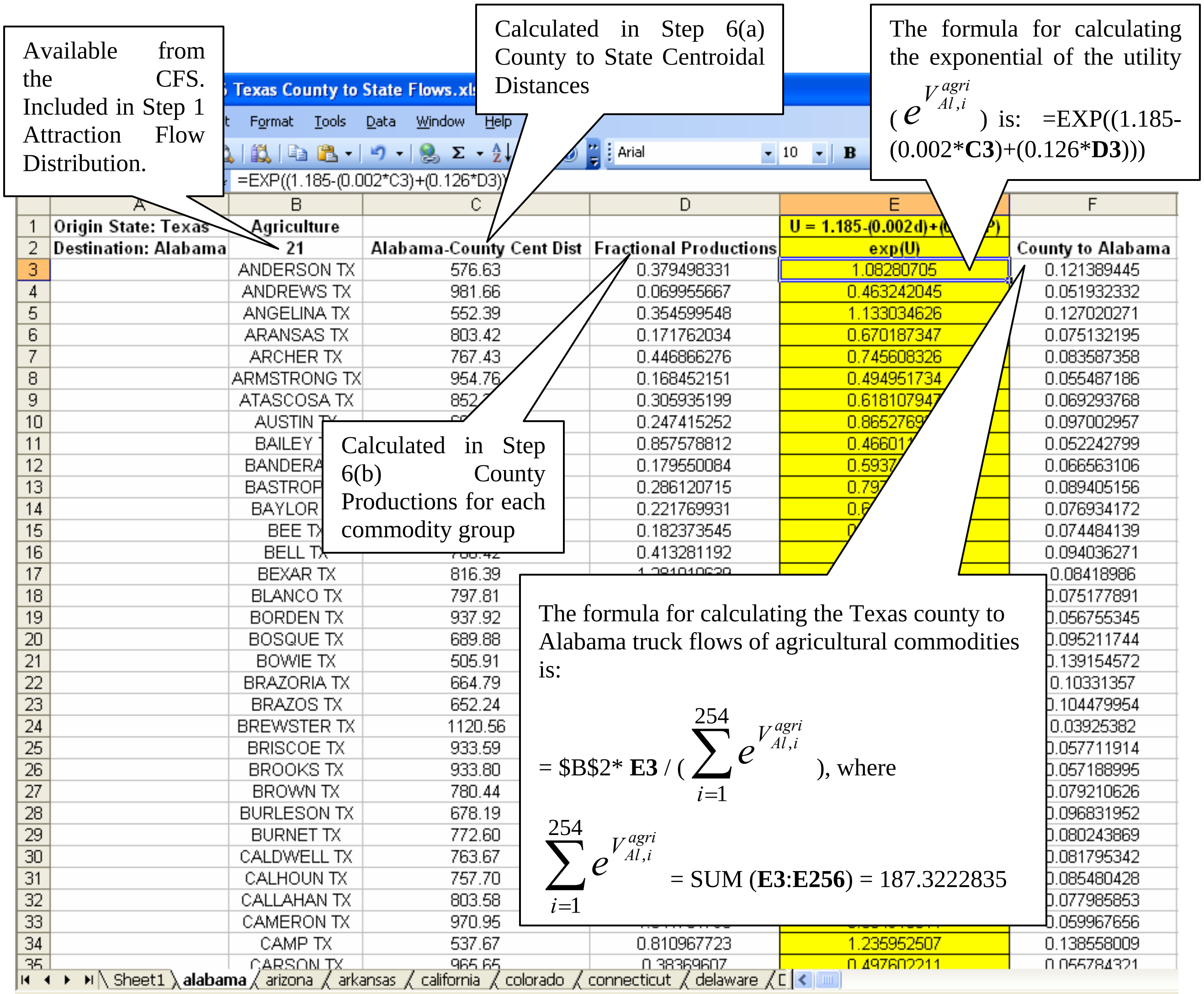
The agricultural flows to Alabama from each Texas county can thus be calculated using the attraction flow distribution model as follows:

$$T_{Al,i}^{agri} = T_{Al,Tx}^{agri} * \frac{e^{V_{Al,i}^{agri}}}{\sum_{i=1}^{254} e^{V_{Al,i}^{agri}}}$$

Where,

$T_{Al,Tx}^{agri}$ = Total agricultural truck flows to Alabama from Texas

The required calculations are illustrated in the screenshot on the opposite page.



	A	B	C	D	E	F
1	Origin State: Texas	Agriculture			U = 1.185-(0.002d)+(0.126P)	
2	Destination: Alabama	21	Alabama-County Cent Dist	Fractional Productions	exp(U)	County to Alabama
3		ANDERSON TX	576.63	0.379498331	1.08280705	0.121389445
4		ANDREWS TX	981.66	0.069955667	0.463242045	0.051932332
5		ANGELINA TX	552.39	0.354599548	1.133034626	0.127020271
6		ARANSAS TX	803.42	0.171762034	0.670187347	0.075132195
7		ARCHER TX	767.43	0.446866276	0.745608326	0.083587358
8		ARMSTRONG TX	954.76	0.168452151	0.494951734	0.055487186
9		ATASCOSA TX	852	0.305935199	0.61810794	0.069293768
10		AUSTIN TX		0.247415252	0.8652769	0.097002957
11		BAILEY		0.857578812	0.46601	0.052242799
12		BANDERA		0.179550084	0.5937	0.066563106
13		BASTROP		0.286120715	0.79	0.089405156
14		BAYLOR		0.221769931	0.6	0.076934172
15		BEE TX		0.182373545		0.074484139
16		BELL TX		0.413281192		0.094036271
17		BEXAR TX	816.39			0.08418986
18		BLANCO TX	797.81			0.075177891
19		BORDEN TX	937.92			0.056755345
20		BOSQUE TX	689.88			0.095211744
21		BOWIE TX	505.91			0.139154572
22		BRAZORIA TX	664.79			0.10331357
23		BRAZOS TX	652.24			0.104479954
24		BREWSTER TX	1120.56			0.03925382
25		BRISCOE TX	933.59			0.057711914
26		BROOKS TX	933.80			0.057188995
27		BROWN TX	780.44			0.079210626
28		BURLESON TX	678.19			0.096831952
29		BURNET TX	772.60			0.080243869
30		CALDWELL TX	763.67			0.081795342
31		CALHOUN TX	757.70			0.085480428
32		CALLAHAN TX	803.58			0.077985853
33		CAMERON TX	970.95			0.059967656
34		CAMP TX	537.67	0.810967723	1.235952507	0.138558009
35		CARSON TX	965.65	0.38369607	0.497602211	0.055784321

Step 6(c): Compute State-to-Texas County Truck Flows

State-to-Texas county truck flows for the nine commodity groups are estimated from the state-to-Texas truck flows reported in the CFS and the utility equations for the production flow distribution model developed in Step 5. In addition, disaggregating the state-to-Texas truck flows to generate state-to-Texas county truck flows using the calibrated production flow distribution model requires the fractional attraction level by each of the Texas counties for each commodity group.

Fractional Attraction Level of Texas Counties

The fractional attraction level of each commodity group destined for each of the Texas counties was calculated from the data captured in the IMPLAN database developed by the Minnesota IMPLAN Group (MIG) Inc. The IMPLAN database provides data on the total annual "Institutional Commodity Demand" in millions of dollars for a total of 528 commodities by each county in Texas (for example, see opposite page for a screenshot of the commodity demand information for Angelina county captured by IMPLAN). These 528 commodities were grouped into the commodity groups listed in Table 1 on page 8 of the manual to compute the total demand in millions of dollars for each commodity group by each of the Texas counties. The county demand for each commodity group by each Texas county was saved in an Excel file (see County Attractions for each commodity group on the CD).

Microsoft Excel - Institution Commodity Demand (SA001)

	A	B	C	D	E	F	G	H	I	J
1		**Institution Commodity Demand**								
2		Commodity			Households	Federal Gov	State & Local	Capital	Inventory	Foreign Exports
3	1	Dairy Farm Products			0.009	0.000	0.000	0.000	0.000	0.001
4	2	Poultry and Eggs			0.226	0.000	0.038	0.000	0.001	0.072
5	3	Ranch Fed Cattle			0.000	0.000	0.000	0.000	0.019	0.058
6	4	Range Fed Cattle			0.000	0.000	0.000	0.000	0.006	0.018
7	5	Cattle Feedlots			0.000	0.000	0.000	0.000	0.000	0.001
8	6	Sheep- Lambs and Goats			0.000	0.000	0.000	0.000	0.000	0.001
9	7	Hogs- Pigs and Swine			0.000	0.000	0.000	0.000	0.000	0.000
10	8	Other Meat Animal Products			0.000	0.000	0.000	0.000	0.000	0.000
11	9	Miscellaneous Livestock			0.168	0.020	0.003	0.000	0.001	0.133
12	10	Cotton			0.000	0.000	0.000	0.000	0.000	0.583
13	11	Food Grains			0.000	0.000	0.000	0.000	0.019	0.774
14	12	Feed Grains			0.026	0.000	0.012	0.000	0.018	0.326
15	13	Hay and Pasture			0.013	0.000	0.006	0.000	0.054	0.110
16	14	Grass Seeds			0.000	0.000	0.007	0.000	0.000	0.000
17	15	Tobacco			0.000	0.000	0.000	0.000	0.000	0.000
18	16	Fruits			0.758	0.000	0.016	0.000	0.000	0.017
19	17	Tree Nuts			0.047	0.000	0.000	0.000	0.000	0.048
20	18	Vegetables			0.843	0.000	0.058	0.000	0.000	0.119
21	19	Sugar Crops			0.000	0.000	0.000	0.000	0.000	0.000
22	20	Miscellaneous Crops			0.001	0.000	0.000	0.000	0.000	0.000
23	21	Oil Bearing Crops			0.003	0.000	0.000	0.000	0.000	0.047
24	22	Forest Products			0.000	0.000	0.000	0.000	0.000	0.000
25	23	Greenhouse and Nursery Produc			0.510	0.000	0.094	0.000	0.006	0.098
26	24	Forestry Products			0.236	0.000	0.000	0.000	0.000	0.014
27	25	Commercial Fishing			0.095	0.000	0.008	0.000	0.000	0.026
28	26	Agricultural- Forestry- Fishe			0.075	0.000	0.000	0.000	0.000	0.002

However, the county attractions for each commodity group obtained from IMPLAN are in millions of dollars. Since the commodity tonnage attracted are required, the value data were converted to tonnage by applying the value to weight factors for each commodity group listed in Table 4 on page 49 of this manual. In other words, the value-to-weight ratios for each commodity group are applied to the county attractions obtained from IMPLAN to convert the value in millions of dollars to tonnage. Once the total commodity tonnage attracted to each county are calculated, the fractional attractions in each county for each commodity group can be determined. The Excel screenshot on the opposite page illustrates the required calculations for agricultural commodities.

The formula for calculating the fractional attractions is: C3/Total agricultural tonnage attracted to all Texas counties.

The formula for calculating agricultural tonnage is: B3/0.553.

Agricultural demand obtained from IMPLAN

County Attractions for each commodity group

=C3*100/C$258

	COUNTY ATTRACTIONS	Agriculture			Raw material		
		Value ($ mil)	tons (000)	% tons	Value ($ mil)	tons (000)	% tons
3	ANDERSON TX	12.2566433	22.16391193	0.246478221	1.1222784	8.197796932	0.087393565
4	ANDREWS TX	5.4873109	9.922804521	0.110348535	2.3635117	17.26451205	0.184050333
5	ANGELINA TX	14.30988097	25.87681912	0.287768349	0.491954173	3.593529385	0.038309237
6	ARANSAS TX	15.0538703	27.22218861	0.3027298	0.3814163	2.786094229	0.029701481
7	ARCHER TX	5.0131151	9.065307595	0.100812568	0.5294558	3.867463842	0.041229547
8	ARMSTRONG TX	3.7372896	6.758209042	0.075156017	0.2538068	1.853957633	0.01976433
9	ATASCOSA TX	9.5289465	17.23136799	0.191624878	2.9653487	21.66069175	0.230916317
10	AUSTIN TX	6.468213458	11.69658853	0.130074255	0.08124508	0.593462965	0.006326681
11	BAILEY TX	16.7381795	30.2679557	0.336600863	0.1280877	0.935629657	0.009974388
12	BANDERA TX	3.4857177	6.30328698	0.070096965	0.2380339	1.738742878	0.01853607
13	BASTROP TX	8.8804588	16.05869584	0.178583943	0.1438001	1.050402484	0.011197938
14	BAYLOR TX	6.5111193	11.77417595	0.130937081	0.1240635	0.906234478	0.009661018
15	BEE TX	7.490634572	13.54545131	0.150634904	1.528031346	11.16166067	0.118990178
16	BELL TX	42.28340612	76.46185555	0.850309376	1.145522345	8.367584698	0.089203607
17	BEXAR TX	235.7497445	426.3105687	4.740872049	25.13714129	183.61681	1.957468303
18	BLANCO TX	1.522828281	2.753758193	0.030623719	0.094015788	0.686747902	0.007321156
19	BORDEN TX	3.52370284	6.371976202	0.070860837	0.000594466	0.004342339	4.6292E-05
20	BOSQUE TX	3.993441481	7.221413167	0.080307171	0.375079965	2.739809824	0.02920806
21	BOWIE TX	15.23601039	27.55155585	0.306392594	0.984722034	7.193002438	0.076681837
22	BRAZORIA TX	40.73673936	73.66498981	0.819206271	2.038914913	14.89346174	0.158773477
23	BRAZOS TX	27.14676983	49.08999969	0.545915172	6.704869002	48.97639885	0.522118581
24	BREWSTER TX	1.864701294	3.371973407	0.037498706	1.479836085	10.80961347	0.115237138
25	BRISCOE TX	7.668473098	13.86703996	0.154211195	0.239113529	1.746629136	0.018620143
26	BROOKS TX	1.729066099	3.126701806	0.034771114	0.064743933	0.472928656	0.005041711
27	BROWN TX	7.622148295	13.78326997	0.153279614	0.704677599	5.147389331	0.054874341
28	BURLESON TX	6.908978277	12.4936316	0.138937932	1.032281282	7.540403816	0.08038535
29	BURNET TX	5.802755802	10.4932293	0.116692058	1.091219984	7.97092757	0.084974998
30	CALDWELL TX	6.072540557	10.981086	0.122117366	0.407201985	2.974448395	0.031709452
31	CALHOUN TX	13.50088024	24.41388831	0.271499534	0.56568552	4.132107524	0.044050812
32	CALLAHAN TX	13.50088024	24.41388831	0.271499534	0.56568552	4.132107524	0.044050812
33	CAMERON TX	68.6914423	124.2159897	1.381368788	10.43765395	76.24290687	0.812796353
34	CAMP TX	3.615297556	6.537608601	0.072702786	0.710057687	5.186688727	0.055293297
35	CARSON TX	10.02174167	18.12249849	0.201534874	0.211307546	1.543517499	0.016454847

Sheet1 Sheet2 Sheet3

Once the fractional county attractions for each commodity group and the state-to-county centroidal distances are available, then the utility equations of the calibrated production flow distribution model can be applied to generate state-to-Texas county flows. Food flows from Alabama to Texas (available from CFS) is used to illustrate the procedure for computing state-to-Texas county truck flows. In essence, the objective is to determine the fraction of the total food truck flows from Alabama to Texas destined for each county in Texas.

The first step is to develop an Excel worksheet that contains the total annual truck flows of food from Alabama to Texas (available from the CFS), the centroidal distances between Alabama and each of the Texas counties, and the fractional attractions of food commodities by each Texas county (see State to Texas County Flows on the CD and the screenshot on the opposite page).

The utility function for truck flows of food commodities from Alabama to Texas developed in Step 5 is:

$$V_{Al,Tx}^{food} = -(0.004 * d_{Al,Tx}) + (0.605 * FA_{Tx}^{food})$$

Where,

Tx = Texas is an attraction state

$d_{Al,Tx}$ = Centroidal distance between Alabama and Texas

FA_{Tx}^{food} = Fractional attractions for food commodities in Texas

The utility function for food flows from Alabama to each Texas county is assumed to be same as the utility function for food flows from Alabama to Texas. Consequently, the utility function for food flows from Alabama to county *j* in Texas is:

$$V_{Al,j}^{food} = -(0.004 * d_{Al,j}) + (0.605 * FA_{j}^{food})$$

Where,

j = Texas county

$d_{Al,j}$ = Centroidal distance between Alabama and county j

FA_{j}^{food} = Fractional attractions for food commodities in county j

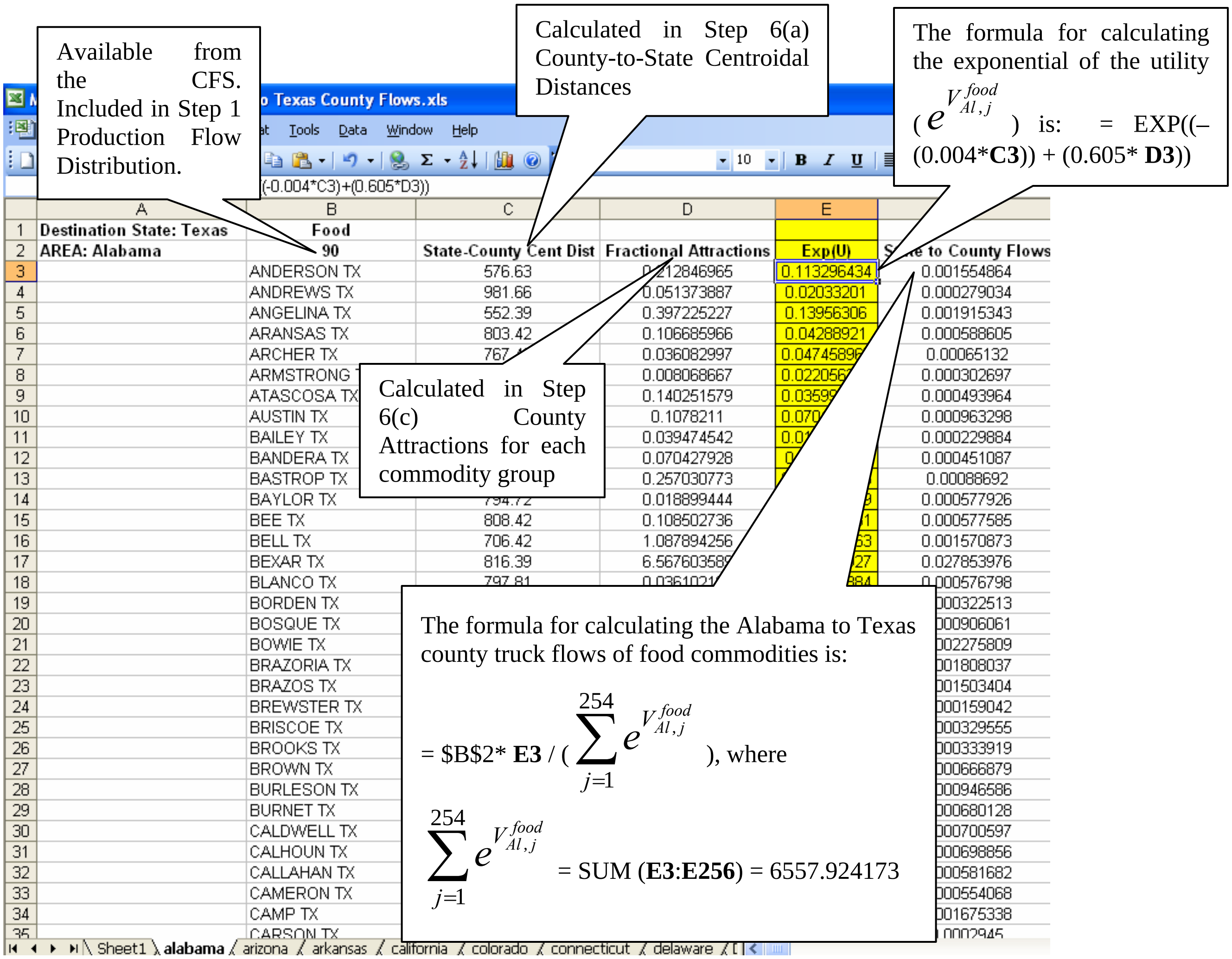
The food flows from Alabama to each Texas county can thus be calculated using the production flow distribution model as follows:

$$T_{Al,j}^{food} = T_{Al,Tx}^{food} * \frac{e^{V_{Al,j}^{food}}}{\sum_{j=1}^{254} e^{V_{Al,j}^{food}}}$$

Where,

$T_{Al,Tx}^{food}$ = Total truck flows of food commodities from Alabama to Texas.

The required calculations are illustrated in the screenshot on the opposite page.


Available from the CFS. Included in Step 1 Production Flow Distribution.
Calculated in Step 6(a) County-to-State Centroidal Distances
The formula for calculating the exponential of the utility ($e^{V_{Al,j}^{food}}$) is: = EXP((–(0.004*C3)) + (0.605* D3))
Calculated in Step 6(c) County Attractions for each commodity group
The formula for calculating the Alabama to Texas county truck flows of food commodities is:
= $B$2* E3 / ($\sum_{j=1}^{254} e^{V_{Al,j}^{food}}$), where
$\sum_{j=1}^{254} e^{V_{Al,j}^{food}}$ = SUM (E3:E256) = 6557.924173
Destination State: Texas
AREA: Alabama
Food
90
State-County Cent Dist
Fractional Attractions
Exp(U)
State to County Flows

Step 6(d): Compute Texas County-to-County Truck Flows

Texas county-to-county truck flows for the nine commodity groups are estimated from the Texas-toTexas truck flows reported in the CFS and the utility equations for the attraction flow distribution and production flow distribution models developed in Step 5. In addition, disaggregating the Texas-to-Texas truck flows using the calibrated attraction flow distribution and production flow distribution models requires the fractional production level by (calculated in Step 6(b)) and the fractional attraction level of (calculated in Step 6(c)) each of the Texas counties for each commodity group, respectively. Once the fractional attractions and productions for each Texas county for each commodity group, and the county-to-county centroidal distances (calculated in Step 6(a)) are available, then the attraction flow distribution and production flow distribution models can be applied to compute Texas county-to-Texas county flows.

Texas County-to-Texas Flows

It is first necessary to determine the total Texas-to-Texas flows that originate in each Texas County. Intra-state truck flows of food commodities (available from CFS) are used to illustrate the procedure for computing Texas county-to-county truck flows.

The first step is to develop an Excel worksheet that contains the total annual intra-state truck flows of food commodities in Texas (available from the CFS), the centroidal distances between Texas and each of the Texas counties, and the fractional production of food commodities by each Texas county.

The utility equation for truck flows of food commodities to attraction state j from Texas developed in Step 5 is:

$$V_{j,Tx}^{food} = -(0.003 * d_{j,Tx}) + (0.504 * FP_{Tx}^{food})$$

Where,

Tx = Texas is a production state

$d_{j,Tx}$ = Centroidal distance between state j and Texas

FP_{Tx}^{food} = Fractional productions in Texas of food commodities

Note, however, that in this case the attraction state is also Texas. The utility function for truck flows of food commodities to Texas from each county in Texas is thus:

$$V_{Tx,i}^{food} = -(0.003 * d_{Tx,i}) + (0.504 * FP_{i}^{food})$$

Where,

$d_{Tx,i}$ = Centroidal distance between Texas and county i

FP_{i}^{food} = Fractional productions of food commodities in county i

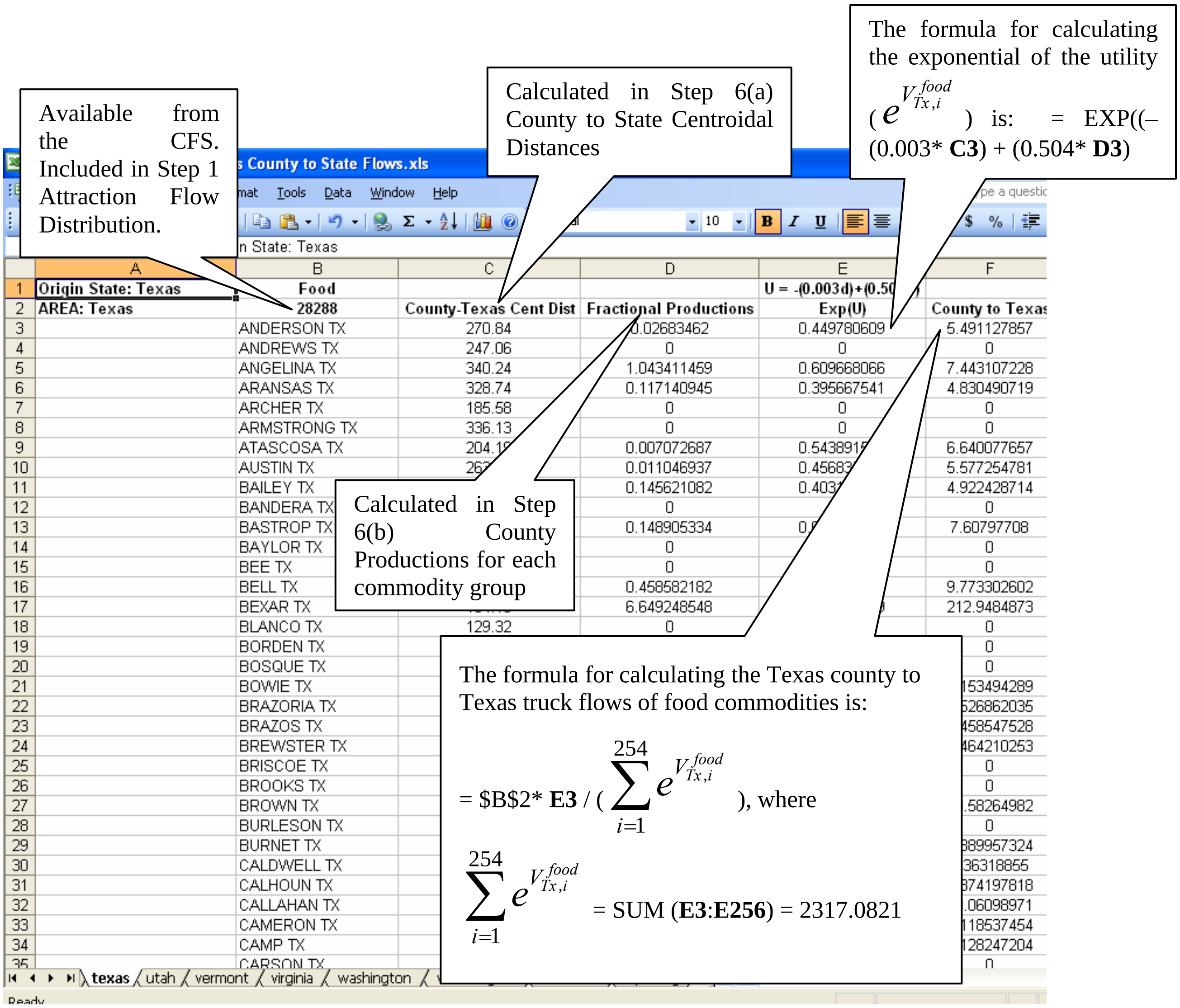
The intra-state food flows destined for Texas from each Texas county can thus be calculated using the attraction flow distribution model as follows:

$$T_{Tx,i}^{food} = T_{Tx,Tx}^{food} * \frac{e^{V_{Tx,i}^{food}}}{\sum_{i=1}^{254} e^{V_{Tx,i}^{food}}}$$

Where,

$T_{Tx,Tx}^{food}$ = Total intra-state truck flows of food commodities

The required calculations are illustrated in the screenshot on the next page.


Available from the CFS. Included in Step 1 Attraction Flow Distribution.
Calculated in Step 6(a) County to State Centroidal Distances
The formula for calculating the exponential of the utility ($e^{V_{Tx,i}^{food}}$) is: = EXP((–(0.003* **C3**) + (0.504* **D3**)
Calculated in Step 6(b) County Productions for each commodity group
The formula for calculating the Texas county to Texas truck flows of food commodities is:
$= \$B\$2 * \mathbf{E3} / \left(\sum_{i=1}^{254} e^{V_{Tx,i}^{food}} \right)$, where
$\sum_{i=1}^{254} e^{V_{Tx,i}^{food}}$ = SUM (**E3**:**E256**) = 2317.0821
County to State Flows.xls
Origin State: Texas
AREA: Texas
Food
28288
County-Texas Cent Dist
Fractional Productions
U = -(0.003d)+(0.50
Exp(U)
County to Texas
ANDERSON TX 270.84 0.02683462 0.449780609 5.491127857
ANDREWS TX 247.06 0 0 0
ANGELINA TX 340.24 1.043411459 0.609668066 7.443107228
ARANSAS TX 328.74 0.117140945 0.395667541 4.830490719
ARCHER TX 185.58 0 0 0
ARMSTRONG TX 336.13 0 0 0
texas utah vermont virginia washington

Texas County-to-County Flows

Once the total truck flows destined for Texas that originate in each Texas County have been calculated, the Texas county-to-county truck flows can be computed for each of the nine commodity groups. Intra-state food flows is used to illustrate the procedure for computing Texas county-to-county truck flows.

The first step is to develop an Excel worksheet that contains the total annual truck flows of food commodities from each county in Texas that are destined for Texas, the inter-county centroidal distances (developed in Step 6(a)), and the fractional attractions of food commodities by each Texas county (see Intercounty Food on the CD and the screenshot on the opposite page).

The utility function for truck flows of food commodities from county *i* to county *j* in Texas developed in Step 5 is:

$$V_{i,j}^{food} = -(0.004 * d_{i,j}) + (0.605 * FA_j^{food})$$

Where ,

$d_{i,j}$ = Centroidal distance between county *i* and county *j*

FA_j^{food} = Fractional attractions for food commodities in county *j*

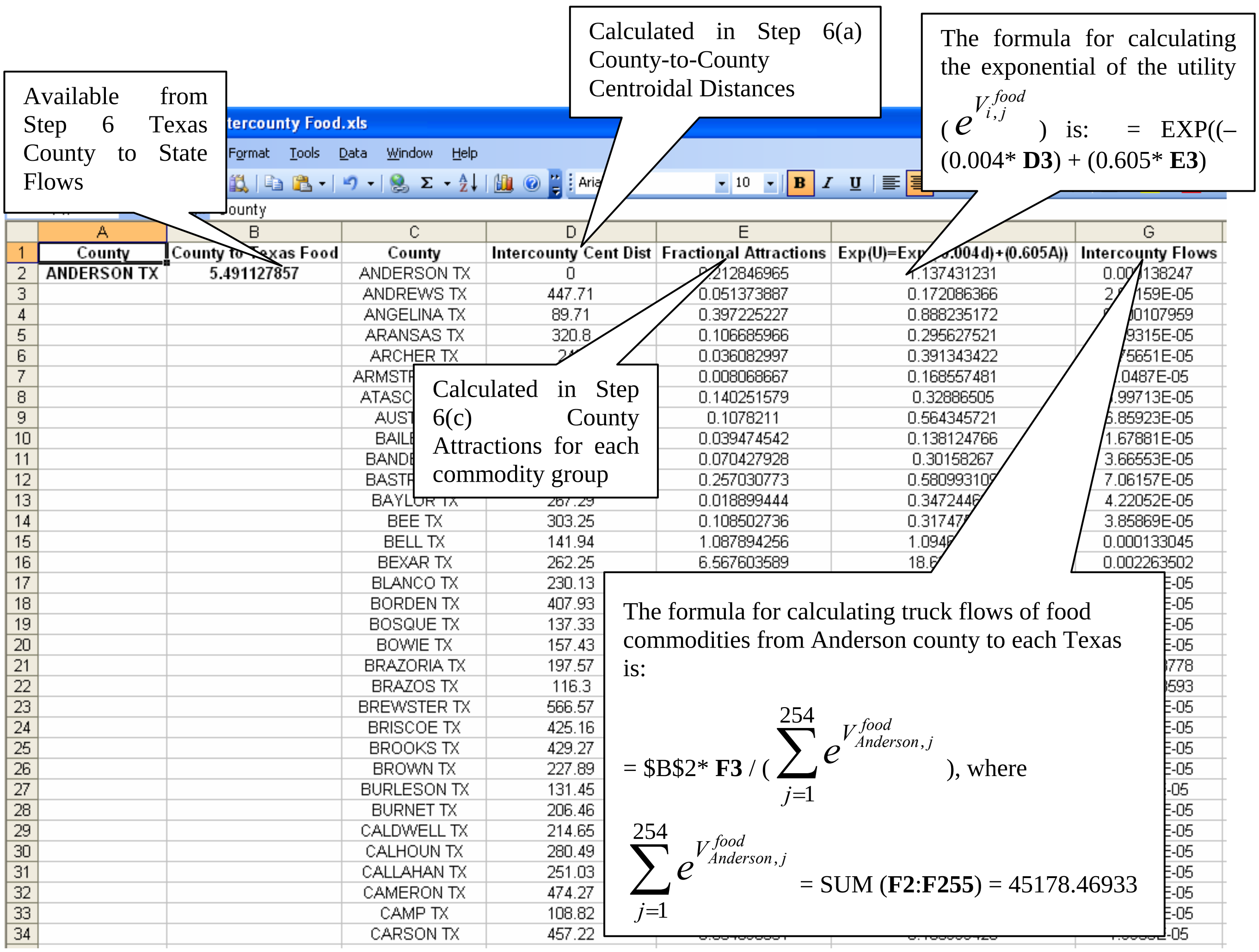
The food flows from county *i* to county *j* in Texas can thus be calculated using the production flow distribution model as follows:

$$T_{i,j}^{food} = T_{i,Tx}^{food} * \frac{e^{V_{i,j}^{food}}}{\sum_{j=1}^{254} e^{V_{i,j}^{food}}}$$

Where,

$T_{i,Tx}^{food}$ = Total truck flows of food commodities from county *i* destined for Texas.

The required calculations for calculating the food commodity flows from Anderson county to each county in Texas are illustrated in the screenshot on the opposite page.


Available from Step 6 Texas County to State Flows
Calculated in Step 6(a) County-to-County Centroidal Distances
The formula for calculating the exponential of the utility ($e^{V_{i,j}^{food}}$) is: = EXP((–(0.004* **D3**) + (0.605* **E3**)
Calculated in Step 6(c) County Attractions for each commodity group
The formula for calculating truck flows of food commodities from Anderson county to each Texas is:
$= \$B\$2 * \mathbf{F3} \,/\, (\sum_{j=1}^{254} e^{V_{Anderson,j}^{food}})$, where
$\sum_{j=1}^{254} e^{V_{Anderson,j}^{food}}$ = SUM (**F2**:**F255**) = 45178.46933
tercounty Food.xls
Format Tools Data Window Help
County
County to Texas Food
Intercounty Cent Dist
Fractional Attractions
Exp(U)=Exp(.004d)+(0.605A))
Intercounty Flows
ANDERSON TX 5.491127857
ANDERSON TX 0 0.212846965 1.137431231
ANDREWS TX 447.71 0.051373887 0.172086366
ANGELINA TX 89.71 0.397225227 0.888235172
ARANSAS TX 320.8 0.106685966 0.295627521
ARCHER TX 0.036082997 0.391343422
0.008068667 0.168557481
0.140251579 0.32886505
0.1078211 0.564345721 6.85923E-05
0.039474542 0.138124766 1.67881E-05
0.070427928 0.30158267 3.66553E-05
0.257030773 7.06157E-05
0.018899444 4.22052E-05
BEE TX 303.25 0.108502736 3.85869E-05
BELL TX 141.94 1.087894256 0.000133045
BEXAR TX 262.25 6.567603589 0.002263502
BLANCO TX 230.13
BORDEN TX 407.93
BOSQUE TX 137.33
BOWIE TX 157.43
BRAZORIA TX 197.57
BRAZOS TX 116.3
BREWSTER TX 566.57
BRISCOE TX 425.16
BROOKS TX 429.27
BROWN TX 227.89
BURLESON TX 131.45
BURNET TX 206.46
CALDWELL TX 214.65
CALHOUN TX 280.49
CALLAHAN TX 251.03
CAMERON TX 474.27
CAMP TX 108.82
CARSON TX 457.22