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New Jersey's Science & Technology University

Transportation Economic and Land Use System (TELUS)

Overview and Documentation of the TELUS Economic Input-Output Model

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1. Introduction

The present document represents a thorough rewrite of the earlier TELUS IO model (Transportation, Economic and Land-Use System, Input-Output) documenting report: *A Regional Input-Output Model for Estimating Economic Impacts in TELUS: Role, Data Sources and Technical Specifications*, (H. Robison and K. Gneiting, November 26, 1999). The earlier report presented data sources and methods for building single-region models and the outlines of an algorithm for estimating interregional trade as needed for the inter-county and rest-of-state impacts aspect of the TELUS IO component. The paper was presented at the TELUS IO Model Peer Review Meeting at NJIT (New Jersey Institute of Technology) in November 1999. During the 2001 EMSI-NJIT contract year, EMSI (Economic Modeling Specialists, Inc.) built models reflecting the earlier documentation for the 105 MPOs (Metropolitan Planning Organizations) shown in Appendix A.

Starting with the 2002 EMSI-NJIT contract year, models were built utilizing the Rutgers University, CUPR R/ECON I-O (Center for Urban Policy Research) modeling system. The R/ECON system has been custom-outfitted with the interregional trade algorithm utilized by EMSI in building models the first year, i.e., models constructed during the 2001 EMSI-NJIT contract year for the MPOs shown in Appendix A. Given the basic similarity in data sources between the EMSI and R/ECON models, the resulting TELUS models should be fundamentally the same.[1] The 82 models completed in 2002, 79 models in 2003, and 74 models in 2004 are shown in Appendices B, C, and D respectively.

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[1] One difference between the first year EMSI models and R/ECON models pertains to aggregation. Given computer improvements since the 1999 design date of the original EMSI IO modeling software, the R/ECON software permits construction of individual region models with the full sectoral detail of the U.S. National IO model, approximately 500 sectors. In contrast, the original EMSI software required sectoral aggregation down to the approximately 50 sectors directly impacted by transportation projects. The original EMSI approach thereby results in a degree of aggregation error, though assuring that "first-order aggregation error" will be zero (see: Morimoto, 1970).

A key component of the TELUS IO model is a set of *translators* that capture the direct spending effect of transportation construction projects. The TELUS IO model requires 100 translators for each state, or 5,000 translators overall. Documentation of the translator assembly process appears in a separate EMSI documents: *TRANSLATOR DOCUMENTATION: Mapping Transportation Construction and Maintenance Projects into Economic Sectors for Use in the TELUS Multiregional Input-Output Model*, (H. Robison and W. Webb, December, 2002) and *EMSI Process for Translator Development*.

1.1. Challenges Posed by the TELUS IO Component

Constructing an IO component for TELUS presents special challenges. Impacts are to be estimated and displayed for each MPO County, and for the rest of the host state.[2] MPOs may consist of many counties. The Dallas-Fort Worth MPO, for example, has 16 counties, requiring a model with 17 regions; the 17th region represents the rest of the state of Texas. As discussed below, theoretical considerations require additional sub-regional delineation. With current regional IO modeling technique calling for single-region base models with approximately 500 industrial sectors, the size of a full multiregional IO model might be 10,000 x 10,000 or more in the case of a 20-region model (500 sectors x 20 regions). Addressing the size of a multiregional model alone is therefore a challenge.

Building TELUS IO components poses other challenges as well. While the procedures for building single-region models are well established,[3] the same cannot be said of multi-region models. Previous applications have employed a type of gravity mechanism (see for example

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[2] TELUS displays job, income, and gross regional product impacts for five industrial sectors, construction, manufacturing, retail/wholesale, services, and government/other. In addition, aggregate impacts are shown for state, local and federal taxes. The various impact measures are displayed for the individual counties of the MPO, the MPO as a whole (i.e., sum of county impacts), to the state economy outside the MPO, and for the state as a whole (i.e., sum of MPO plus in-state but out-of-MPO impacts).

[3] Nowadays, best practice calls for some variation on the econometric approach first proposed by Stevens and others.

Leontief and Strout, 1963 and Polenske, 1980), or they have assumed trade patterns based on apparent hierarchical trade relationships (see for example Robison, 1984). The approach adopted for the TELUS IO module combines elements of both applications by applying a gravity component to the study regions defined on principles of hierarchical trade theory.

2. The TELUS Multiregional IO (MRIO) Algorithm

2.1. Mathematics of the Single Region Model

Equation (1) shows the basic transformation of the national IO coefficients matrix into a regional IO coefficients matrix for region r.

$$A^{rr} = \left\{ \hat{\gamma}^{rr} \right\} A \tag{1}$$

where:

A^{rr} = regional coefficients matrix

A = national coefficients matrix

A single superscripted r would normally suffice to denote a single region r. The adoption of dual superscripts anticipates multiregional formulations described below. The pre-multiplying array $\hat{\gamma}$ is a diagonal matrix of regional purchase coefficients (RPC). In general, these illustrate the portion of regional demand satisfied by regional supplies.

2.2. The Rutgers RPC Estimating Equation

Adjustments for interregional trade[4] are made using techniques developed by Treyz and Stevens (1985, pp. 553-554). In this paper, the authors show that they estimate the regional purchase coefficients (RPC) – the proportion of demand for an industry's goods or services that is fulfilled by local suppliers – using the following equation (2):

[4] These adjustments do not account for international exports.

$$\ln\left\{\frac{-1}{\ln\left[\ln\left(\frac{LS}{D}\right)\right]}\right\} = \ln k + \sum_{i=1}^{n} \alpha_j Z_j + \varepsilon \qquad (2)$$

Using standard OLS regression techniques where:

D = local demand for the industries production and estimated as discussed in the previous section;

LS = the amount of local demand that is fulfilled by local supplies;

k = an intercept term;

Z_j = one of the n explanatory variables listed in Table 1;

α_j = the estimated parameter value associated with variable Zj.

This odd nonlinear functional form not only yields high correlations between the estimated and actual values of the RPCs at the state level, but it also assures that the RPC value ranges strictly between 0 and 1. The results of the Treyz and Stevens (1985) empirical implementation of this equation are shown in Table 1. The table shows that total local industry demand (Z1), the supply/demand ratio (Z2), the weight/value ratio of the good (Z3), the region's size in square miles (Z4), and the region's average establishment size in terms of employees for the industry compared to the nation's (Z5) are the variables that influence the value of the RPC across all regions and industries. The latter of these maintains the least leverage on RPC values.

Because the U.S. Department of Transportation's 1977 Commodity Transportation Survey (CTS) data used to estimate this equation were applied at the state level only, it is important for the purposes of TELUS that the local industry demand, the supply/demand ratio, and the region's size in square miles are included in the equation because they allow the equation to extrapolate the estimation of RPCs for areas smaller than states.

It should also be noted here that the CTS data only cover manufactured goods. Thus, RPC estimates for services are generally based on a truncation of each industry's supply/demand ratio.

Table 1: Parameters for the Four-Digit Regional Purchase Coefficients

Variable	Parameter	t-statistic
Intercept (k)	21.33	
Demand	0.18	8.73
Supply/demand	0.72	16.17
Weight/value	0.29	12.64
Percentage of U.S. land area	0.27	8.64
Establishments per employee relative to nation	0.12	2.54
Midwest Census Division	-0.12	-1.98
Plains Census Division	-0.61	-6.64
East South Central Census Division	-0.58	-7.93
Pacific Census Division	0.43	4.48
Tobacco industry (SIC 21)	1.05	2.84
Textile industry (SIC 22)	0.52	3.35
Furniture industry (SIC 25)	0.36	1.69
Printing and publishing industry (SIC 27)	0.81	3.89
Rubber industry (SIC 30)	-0.67	-3.38
Stone, clay, and glass industry (SIC 32)	0.24	2.56
Instruments industry (SIC 38)	0.37	1.95
Flour and grain mill products industry (SIC 2041)	-.064	-2.23
Electrical machinery, NEC (SIC 3599)	1.16	4.25

Note: F=58.687, with 1,348 degrees of freedom; R2=0.4405, but the R2 between the estimated RPCs (after transformation) and the actual values from the CTS was 0.7413.

2.3. Mathematics of the Multiregional Model

The algorithm for estimating multiregional IO coefficients is illustrated with the example of an economy with three sub-regions. The combined region is referred to as the *meta-region.* The rational for identifying meta-regions and constituent sub-regions is discussed in sections below.

The basic expression for transforming national model IO coefficients into multiregional IO coefficients is illustrated for our hypothetical three-region meta-region in equation (3). The lead matrix on the equation's right is a 3x3-partitioned matrix, where each sub-matrix, denoted by $\hat{\gamma}$, is a diagonal sub-matrix.

$$\begin{Bmatrix} A^{rr} & A^{rs} & A^{rt} \\ A^{sr} & A^{ss} & A^{st} \\ A^{tr} & A^{ts} & A^{tt} \end{Bmatrix} = \begin{Bmatrix} \hat{\gamma}^{rr} & \hat{\gamma}^{rs} & \hat{\gamma}^{rt} \\ \hat{\gamma}^{sr} & \hat{\gamma}^{ss} & \hat{\gamma}^{st} \\ \hat{\gamma}^{tr} & \hat{\gamma}^{ts} & \hat{\gamma}^{tt} \end{Bmatrix} \begin{Bmatrix} A & 0 & 0 \\ 0 & A & 0 \\ 0 & 0 & A \end{Bmatrix} \qquad (3)$$

Sub-matrices on the partition diagonal ($\hat{\gamma}^{rr}, \hat{\gamma}^{ss}, \hat{\gamma}^{tt}$) are the single region RPCs estimated as described in the previous section. Sub-matrices on the off-diagonal convey multiregional RPCs. As an example, the RPC $\hat{\gamma}^{rs}$ indicates the portion of region s overall demand satisfied by supplies from region r.

The RPCs are estimated using gravity assumptions as follows. Again, using region r as a supplier to region s, vectors of excess supply for each region are computed as follows:

$$E^r = X^r - A^{rr} X^r \qquad (4)$$

where:

X^r = region r vector of total gross outputs

E^r = region r vector of excess supplies

Next, vectors of unmet demand are computed. For region r, these appear as:

$$M^r = \left[A - A^{rr}\right]X^r \tag{5}$$

where:

M^r = region r vector of unmet demand.

Finally, multiregional RPCs are formed as follows:

$$\frac{\alpha E_i^r M_i^s}{d_{rs}^b} = \alpha_i^{rs} \tag{6}$$

where:

d_{ij} = travel time between region r and region s

b = distance exponent (assumed equal to 1)

α = gravitational constant.

The algorithm computes the gravitational constant α in such a manner that no region exports (beyond the meta-region boundary) more than 95% of its production of any given industry, nor does any region meet more than 95% of its demand for any commodity from suppliers located within the meta-region.

2.4. Data Sources for Model Construction

The regional economic data on which the R/ECON I-O system is built are derived from federally supplied data from a variety of sources listed below:

- *County Business Patterns Data*, US Bureau of the Census, Department of Commerce, http://www.census.gov:80/epcd/cbp/view/cbpview.html

- *Earnings by Industry (Tables SA05 & CA05)*, Regional Economic Measurement Division, Bureau of Economic Analysis, US Department of Commerce, http://www.bea.doc.gov/bea/regional/reis/
- *Wage and Salary Disbursements by Industry (Table SA07)*, Regional Economic Measurement Division, Bureau of Economic Analysis, US Department of Commerce http://www.bea.doc.gov/bea/regional/reis/
- *Full- and Part-time Employment by Industry (Tables SA25 & CA25)*, Regional Economic Measurement Division, Bureau of Economic Analysis, US Department of Commerce, http://www.bea.doc.gov/bea/regional/reis/
- *Gross State Product (GSP) Data*, Bureau of Economic Analysis, US Department of Commerce, http://www.bea.doc.gov/bea/regional/gsp/
- *Covered Employment and Wages (ES202 data)*, Bureau of Labor Statistics, ftp://ftp.bls.gov/pub/special.requests/cew/
- *Value of Production by Commodity, Census of Agriculture*, National Agricultural Statistics Service, US Department of Agriculture, http://govinfo.kerr.orst.edu/ag-stateis.html/
- *Census of Government Finances*, US Bureau of the Census, Department of Commerce, http://www.census.gov:80/govs/www/cog.html

To produce earnings and total employment by region, County Business Patterns (CBP) data on payroll and payroll employment,[5] which are available at the four-digit Standard Industrial Classification (SIC) level for non-agricultural and non-government sectors, are compiled for the

[5] Payroll employment is the number of employees that receives regular wages and salaries. Hence, these figures do not include business proprietors unless they receive wages as well as income that they accrue by owning the business.

specified geography.[6] The CBP payroll and payroll employment data are subsequently enhanced using BEA's state-level *Table SA05* earnings/payroll and *Table SA25* total-employment /payroll-employment ratios at the two-digit SIC level. These ratios are then applied to the detailed sectors in the economic model with which they are associated. Government enterprise and private household employment are obtained separately from the *ES202* files. Sub-national data on agricultural income and employment by industry are derived using the region's share of the national value of production of the commodity. Thus, for agriculture only it is assumed that the sector has the same average earnings per employee everywhere in the US.

To produce value-added and tax-revenue data, the value-added/earnings ratios by industry are calculated from the two-digit SIC data and the data on earnings derived as discussed above. Similar calculations from the same datasets are made to estimate indirect federal-government-tax/earnings ratios and indirect state-and-local-government-tax/earnings ratios. The state-local split of indirect business taxes and of personal taxes is calculated based on *Census of Government Finances* data for the region. Wages net of taxes are estimated by calculating the share of compensation from the *GSP* data files composed of the wages from BEA's *Table SA07*, which are also only available by state.

The estimated outputs by industry are derived from the labor-income coefficients of the R/ECON I-O national I-O table and the earnings data discussed above. Lahr (2001) delves into a more precise mathematical treatment of the techniques discussed here.

After the above data are collected, regional demand data by industry are estimated using the techniques described in Treyz and Stevens (1985, equation 2). That is, in order to derive regional demand by industry, the regional output estimates (obtained using the techniques discussed

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[6] The smaller a region is from an economic perspective, the greater are the number of the disclosure problems in CBP data. Hence, before using the *CBP* data in R/ECON I-O, all disclosure problems were filled in using a method like that described in Gerking et al. (2001).

above) are first multiplied up the columns of the national direct-requirements matrix. The sums of the rows of the resulting matrix are then obtained to get regional inter-industry demand. To get total regional demand, of course, one must add to inter-industry demand the demand for industry production placed by regional final demand i.e., locally based government operations, regional households, and the region's international exports. The product of regional output and the national final-demand/output ratio estimates regional final demand by industry.

3. Selecting Regions for MRIO Modeling

TELUS impact reporting requirements call for the estimation of impacts for each MPO County and for the rest of the host state. Accordingly, single-region models must be constructed for individual MPO counties, along with trade among these counties. But how should the rest-of-state region, including trade between this region and the MPO counties be treated?

In general, rest-of-state areas will rarely appear as functioning economies appropriate for treatment as stand-alone regions, but rather as *doughnut* areas with unconnected centers and little internal cohesion. Correct treatment of rest-of-state areas will normally require that they be viewed as composed of multiple, largely independent sub-regions. At a minimum then, trade must be estimated among the rest-of-state sub-regions, and between these several sub-regions and the counties of the MPO.

Unfortunately, the demands of the TELUS multiregional modeling problem do not stop here. U.S. state and county boundaries are artifacts of 19th politics (Fox and Kumar, 1965). As a result, economic boundaries routinely cross state lines, and this necessitates the inclusion of out-of-state areas within the larger meta-region of the multiregional IO model. Omission of these out-of-state areas, or failure to recognize the internal character of *doughnut-shaped* rest-of-state regions results in predictable error in TELUS IO model impact estimates. This error is referred to as *spatial misspecification error*. The next 4 sections present theory and guidelines to minimize spatial misspecification error. The first section presents the outlines of central place theory, the fundamental underpinning of regional definition. The second and third sections provide alternative views of spatial misspecification error issue. The first considers the problem as one of spillovers and feedbacks, while the second looks at it in a more technical sense. The final section provides the practical resources used to identify economic sub-regions.

3.1. Central Place Theory

Central place theory (Christaller, 1966 and Losch, 1954) provides the foundation for characterizing the regional trade hierarchy. Central Place theory views the regional landscape with sub-regions defined and ordered according to the goods and services they provide to themselves and to other sub-regions (Berry et al., 1988). Parr (1987) provides taxonomy of goods and services in a central place hierarchy, distinguishing between central place and specialized goods and services. Central place goods and services include items for which there is essentially ubiquitous demand: groceries, consumer durables, movies, air travel, accounting, legal and business services, and so on. Specialized goods and services are items for which production is unique to particular regions: agricultural products, timber, input-oriented manufacturing military installations, federal government offices, and so on.

Lower-order sub-regions supply their own lower-order central place goods and services and obtain higher-order central place goods and services from higher-order sub-regions. Higher-order sub-regions supply their own lower-and higher-order central place goods and services. There is no trade in central place goods and services between same-order sub-regions. Sub-regions at the bottom of the trade hierarchy (lowest-order sub-regions) derive their income from the export of specialized goods to other sub-regions for processing or outside the larger region. Higher-order sub-regions derive their income from the supply of higher-order central place goods and services to lower-order sub-regions and from the export of specialized goods to other sub-regions and to outside the larger region.

TELUS reporting requirements call for the estimation of impacts that spill beyond MPO boundaries to the rest of the state. This proves to be a complex endeavor. For one thing, the rest of the state is almost never a functioning regional economy, and must therefore be subdivided into multiple sub-regions. Beyond this, state boundaries are rarely economic boundaries, and this requires the inclusion of out-of-state areas in the encompassing meta-region.

3.2. The Problem of Spillovers and Feedbacks

The size and choice of sub-regions within the larger meta-region depends on the character of the broader area trade hierarchy of which the state economy is a part. States differ not only in their mix of industries, resource endowments and such, but also in their underlying spatial structures, i.e., number, size, placement and interconnectedness of cities and towns. Regional IO models capture the spread of multiplier effects among industries, and when space is included, as in the multiregional model, they capture the spread of multiplier effects across places as well. Failure to properly capture this spatial aspect of multiplier diffusion can lead to problems in spillover estimation.

Consider a hypothetical example. Figure 1 shows an MPO surrounded by a trade-dominated hinterland. Imagine a transportation project in the MPO that entails input purchases within the MPO plus input purchases outside the MPO at location A. The project will create jobs and incomes both in the MPO and in the vicinity of location A. However, by virtue of the MPOs trade dominance of the hinterland including location A, we can expect feedback job and income effects to the MPO. Failure to recognize the region's spatial structure, specifically the MPOs dominance of location A, could result in the omission of feedback effects, and the accompanying understatement of MPO economic impacts.

Figure 2 shows a variant on the case shown in Figure 1. This time the input supplier at location A is in a neighboring state, and job and income effects in the vicinity of A are properly excluded from the TELUS report. However, the feedback effect to the MPO is still in force, and failure to recognize this would lead to an understatement of MPO impacts.

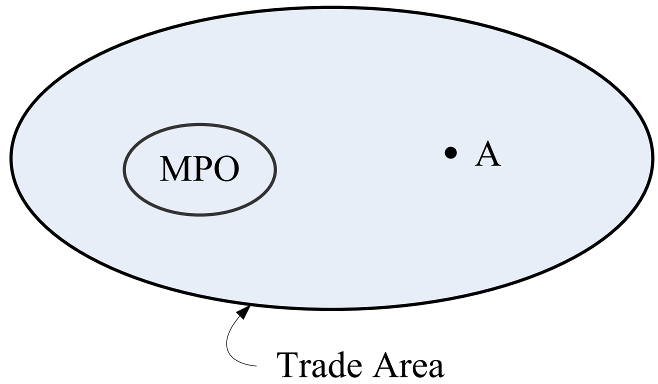

Figure 1: An MPO and its trade partner (e.g. materials supplier B) located within the same trade area

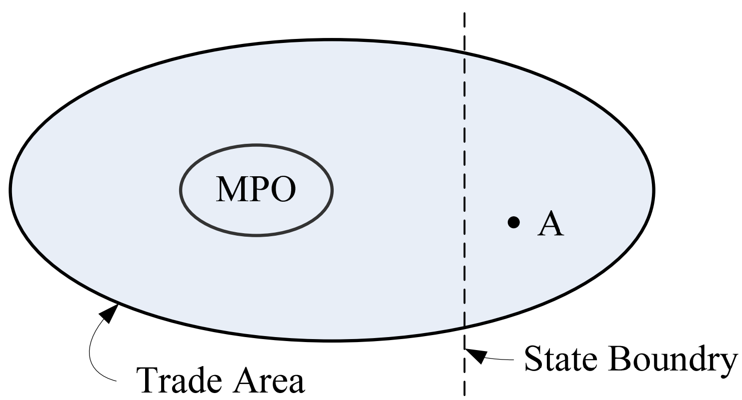

Figure 2: An MPO and its trade partner (e.g. materials supplier B) located within the same trade area, but in two different states

Figure 3 illustrates another possibility. Suppose the supplier of project inputs is located at point B, in the hinterland of a neighboring trade center. The path of spatial multiplier transmission in this case leads to the neighboring center, rather than to the MPO. If the path is instead erroneously led back to the MPO, overstated MPO impacts would result.

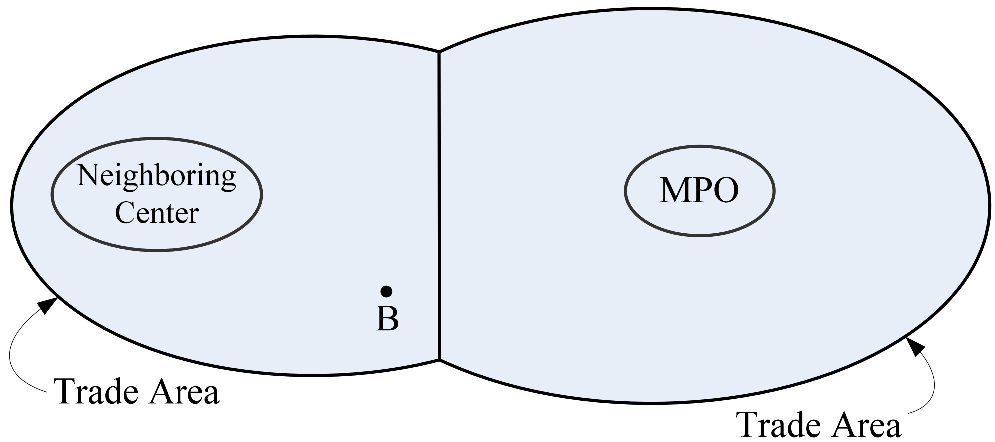

Figure 3: An MPO and its trade partner (e.g. materials supplier B) located within different (neighboring) trade areas

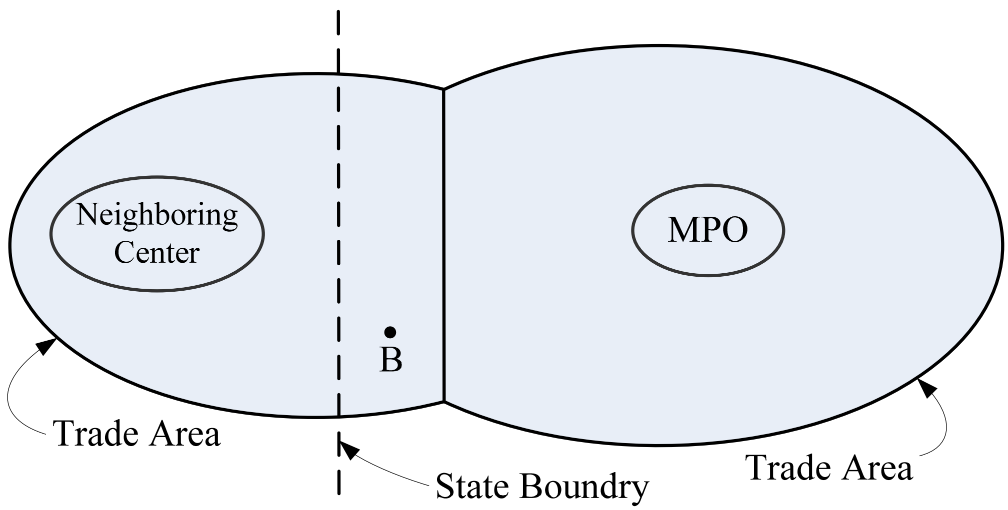

Figure 4: An MPO and its trade partner (e.g. materials supplier B) located within different (neighboring) trade areas, but within the same state

A fourth and final case is illustrated in Figure 4. While point B is located in the MPO host state, B's dominating trade center is located in a neighboring state. In this case, the multiplier effects leading from location B leak across the state boundary, and spill out-of-state. The impacts in the vicinity of B are properly reported, while the lower-to-higher-order multiplier effects are properly excluded. Failure to recognize this feature of the local space economy would lead to overstated impacts.

3.3. Spatial Misspecification Error

Spatial misspecification error occurs when single or multi-regional IO modeling algorithms are applied to regions that are other than functional economies. To illustrate consider the hypothetical collection of political and economic regions depicted in Figure 5. Political boundaries appear with broad dashed lines, while economic boundaries appear with the solid lines. For the sake of discussion, let us refer to the political regions as states.

The depiction shown in Figure 5 shows three states arrayed as though on a line, with empty space elsewhere, and it implicitly conveys a two-order trade hierarchy. Without loss of generality, this simplification illustrates the circumstances that result in spatial misspecification error. In reality, of course, the plane is filled with regions, running in all directions, and trade hierarchies of order greater than two.

Figure 5 explicitly shows three trade centers, A, B, and C. Our interest is in the state centered on A, with political boundaries that include hinterland areas V and W. There are two general conditions for spatial misspecification error and the state centered on A in Figure 5 exhibits both of these conditions:

1. The state economically dominates an area belonging to a neighboring state, as illustrated by A's dominance of region X in Figure 5.
2. The state contains an area that is dominated by a center located in a neighboring state, as illustrated by C's dominance of region V in Figure 5.

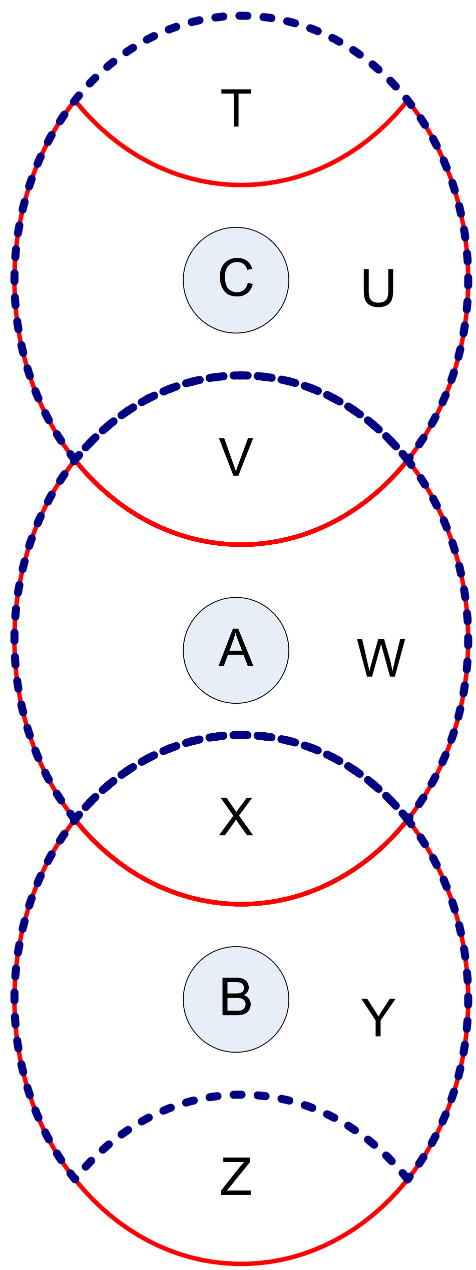

Figure 5: Illustration of the two-order trade hierarchy (blue dashed lines represent state or other administrative/political boundaries; solid red lines represent boundaries of trade regions/areas)

The reason for the error is easily understood. The gravity method for estimating multiregional trade operates on a supply-demand pooling mechanism. Surplus production in one region (i.e., production beyond local demand) is assumed available to meet otherwise unmet demand in other regions, with near trade regions favored over distant trade regions. The solution of course is to divide the larger area into component functional economies, and estimate the trade among these smaller functional economic entities. This is the approach followed in constructing the TELUS multiregional model.

4. Resources for Identifying Central Place Hierarchies

4.1. BEA Economic Areas[7]

The U.S. Department of Commerce, Bureau of Economic Analysis divides the U.S. economy into 172 e*conomic areas*. Boundaries are drawn on economic rather than political or administrative criteria. The work is clearly shaped by central place theory and the related notion of functional economic areas (Fox and Kumar, 1965).

Each BEA economic area consists of a standard metropolitan statistical area (SMSA), or similar area that serves as a center of trade, and the surrounding counties that are economically related to the center. The delineation assures that each area will be relatively self-sufficient in the output of its local service industries.

The 172 BEA economic areas are built-up from 348 smaller component economic areas (CEA). CEAs are defined around a single economic node and the surrounding counties that are economically related to the node. In a sense, therefore, a given BEA economic area can be viewed as a three-order trade hierarchy, with the BEA core as the 3rd and highest order place, followed by the centers of the CEAs (2nd order places), surrounded in turn by the dominated CEA hinterlands.

4.2. Rand McNally Trading Areas

The Rand McNally Commercial Atlas and Marketing Guide (Rand McNally, 1999) provides an alternative collection of central place-based trade areas. The elemental building blocks are 487 b*asic trading areas*. These are areas surrounding at least one b*asic trading center*. A basic trading

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[7] This description is excerpted from U.S. Department of Commerce, Bureau of Economic Analysis, 1975 and 1995.

center is a city that serves as a center for the purchase of shopping goods. Basic trading areas have apparel stores, general merchandise stores, and specialized services such as medical care, entertainment, higher education and a daily newspaper. These follow county lines and are drawn to include the county or counties whose residents make the bulk of their shopping goods purchases in the area's basic trading center(s) or its suburbs.

Moving up the trade hierarchy one level, the 487 basic trading areas are collected to into 47 m*ajor trading areas*, each centered on its own m*ajor trading center*. A major trading center is a city that serves as one of the trading area's primary centers for wholesaling, distribution, banking, and specialized services such as advertising. The major trading area's boundaries are determined after "an intensive study" that considers such factors as physiography, population distributions, newspaper circulation, economic activities, highway facilities, railroad services, suburban transportation, and field reports of experienced sales analysts.

4.3. National Transportation Analysis Regions (NTARs)[8]

The U.S. Department of Transportation (DOT) has defined NTAR regions to "collect and publish information on the interregional movements of goods, including the Commodity Flow Survey (CFS)." NTAR boundaries, like those of the BEA economic areas and Rand McNally trade areas, are constructed on principles grounded in central place theory. NTAR boundaries recognize that transportation demand is molded by economic, social, and physical forces that generally ignore political boundaries. Mountain ranges and the hinterlands of major economic centers are just two of the many characteristics that affect patterns of transportation supply and demand and have little correlation to state lines. NTAR regions are drawn according to functional geography rather than by state or other political units.

[8] This section is excerpted from the U.S. Department of Transportation, Bureau of Transportation Statistics website: http://www.bts.gov/programs/cfs/ntars/ntars.html

NTARs are based on centers of population or economic activity that account for most of the origins, destinations, or transfers of long-distance passenger and commodity movements. Each region is defined to encompass the hinterland of the region's terminals for long distance transportation. Where hinterlands of closely neighboring centers substantially overlap, the regions are combined.

NTARs are defined as combinations of BEA economic areas, in part to be less numerous, and in part to eliminate overlapping hinterlands. The result is 89 NTAR regions that reflect larger centers and hinterlands than the 172 BEA economic areas, though in many cases smaller centers and hinterlands than the 47 Rand McNally major trading areas.

5. Distance Matrices

5.1. Development of Distance Matrices

To incorporate into the models the gravity mechanism that was previously mentioned, distance matrices were built for each of the 85 MPO models. The distance matrices describe the average time required to travel between each of the locations/regions used to build an MPO model. The distance and the average travel time between locations/regions are used to determine the average miles per hour. An adjustment is made to the miles per hour to calibrate for travel difficulty. Unimpeded travel, as might be expected along an interstate highway, receives a degree of difficulty of 1, which does not adjust the speed of travel. Moderately difficult travel receives a degree of difficulty of 2 and the speed of travel is discounted by 20 percent. With travel that is considered to be very difficult, such as in a highly congested city, the speed of travel is cut in half. Then, an adjusted travel time is calculated using the distance and the adjusted miles per hour.

Travel within a location/region is estimated to be an average distance of 20 miles and is also adjusted for a degree of difficulty. Travel to and from certain regions was estimated by selecting a central location in the region as a reference point. For example, the region Jackson, AL (which includes counties in Alabama that are affected by Jackson, MS) has Demopolis, AL as the reference point for the distance matrix calculations.

In order to discriminate between economic and political regions, as described in Section 3, geographic regions were segmented to create the references used in the distance matrix. As an example, Phoenix MPO has a distance matrix comprised of 12 cities/regions, including the single MPO county Maricopa (shown in Appendix E), resulting in a 12 x 12. The matrix is built to define the travel times between each pair of locations. To account for economic interrelationships between different political (administrative) regions, the nearby Albuquerque economic region was divided into two distinct segments: Albuquerque, New Mexico (denoted as

AlbuquerqueAZ, NM) and Albuquerque, Arizona (denoted as Albuquerque, AZ). The former represents the economic influence of the city of Albuquerque, NM on Phoenix, which is contained within the political boundary of the State of New Mexico. The latter represents the economic influence of the city of Albuquerque on Phoenix, which is contained within the political boundary of the State of Arizona. The significance of this distinction was outlined in Section 3.

These segmented regions were then used to estimate the gravity mechanism. As can be seen in the Phoenix MPO distance matrix (Appendix E), adjusted travel time between AlbuquerqueAZ, NM and Las VegasAZ, NV (which represents the economic influence of Las Vegas, NV on Phoenix, which is contained in Nevada) is 10.5 hours. Adjusted travel time within Maricopa County is 0.48 hours (20 miles of travel distance at an average of 50 mph, adjusted for a degree of difficulty of 1.2).

6. MPO Maps

6.1. MPO Regions

The maps of all states containing MPOs were created to highlight the economic and political regions. An example of the Arkansas state map is shown in Appendix F. The outline of Arkansas is represented by the thicker black lines, with portions of surrounding states being included as necessary. The economic meta-region consists of sub-regions delineated by different colors. The center of each sub-region is labeled accordingly. For example, the economic region of Memphis, TN extends across Alabama, Arkansas, Kentucky, Louisiana, Missouri, and, of course, Tennessee. This region is shown in Appendix F as the light blue cross-hatched region labeled 'Memphis'. This map describes the meta-region for all MPOs in Arkansas, and also aids in designing the distance matrices described in the previous section.

Appendices

Appendix A: MPO IO Models Developed In 2001

#	MPO Name	State	City
1	Bay County Transportation Planning Organization	FL	Pensacola
2	Brevard MPO	FL	Viera
3	Broward County MPO	FL	Fort Lauderdale
4	Capital Region Transportation Planning Agency	FL	Tallahassee
5	Charlotte County - Punta Gorda MPO	FL	Punta Gorda
6	Collier County MPO	FL	Naples
7	First Coast MPO	FL	Jacksonville
8	Florida-Alabama Transportation Planning Organization	FL	Pensacola
9	Hernando County MPO	FL	Brooksville
10	Hillsborough County MPO	FL	Tampa
11	Indian River County MPO	FL	Vero Beach
12	Lee County MPO	FL	Fort Myers
13	Martin County MPO	FL	Stuart
14	METROPLAN Orlando	FL	Orlando
15	Metropolitan Transportation Planning Organization	FL	Gainesville
16	Miami-Dade MPO	FL	Miami
17	Ocala - Marion County Transportation Planning Organization	FL	Ocala
18	Okaloosa-Walton Transportation Planning Organization	FL	Pensacola
19	Palm Beach County MPO	FL	West Palm Beach
20	Pasco County MPO	FL	New Port Richey
21	Pinellas County MPO	FL	Clearwater
22	Polk County Transportation Planning Organization	FL	Bartow
23	Sarasota-Manatee MPO	FL	Sarasota
24	St. Lucie MPO	FL	Fort Pierce
25	Volusia County MPO	FL	Daytona Beach
26	Black Hawk Metropolitan Area Transportation Policy Board	IA	Waterloo
27	Corridor Metropolitan Planning Organization	IA	Cedar Rapids
28	Des Moines Area MPO	IA	Urbandale
29	East Central Intergovernmental Association	IA	Dubuque

MPO IO Models Developed In 2001 (Continued)

#	MPO Name	State	City
30	Johnson County COG	IA	Iowa City
31	Sioux City MPO	IA	Sioux City
32	Bannock Planning Organization	ID	Pocatello
33	Bonneville MPO	ID	Idaho Falls
34	Community Planning Association of Southwestern Idaho	ID	Meridian
35	Bi-State Regional Commission	IL	Rock Island
36	Champaign County Regional Planning Commission	IL	Urbana
37	Decatur Area Transportation Study	IL	Decatur
38	Kankakee County Regional Planning Commission	IL	Kankakee
39	McLean County Regional Planning Commission	IL	Bloomington
40	Rockford Area Transportation Study	IL	Rockford
41	Springfield-Sangamon County Regional Planning Commission	IL	Springfield
42	The Chicago Metropolitan Agency for Planning (CMAP)	IL	Chicago
43	Tri-County Regional Planning Commission	IL	Peoria
44	Berkshire MPO	MA	Pittsfield
45	Boston MPO	MA	Boston
46	Cape Cod MPO	MA	Barnstable
47	Central Massachusetts MPO	MA	Worcester
48	Merrimack Valley MPO	MA	Haverhill
49	Montachusett MPO	MA	Fitchburg
50	Northern Middlesex MPO	MA	Lowell
51	Old Colony MPO	MA	Brockton
52	Pioneer Valley MPO	MA	West Springfield
53	Southeast Michigan COG	MI	Detroit
54	Columbia Area Transportation Study Organization	MO	Columbia
55	East-West Gateway Council of Government	MO	St. Louis
56	Joplin Area Transportation Study Organization	MO	Joplin
57	Mid-Amercia Regional Council	MO	Kansas City
58	Ozarks Transportation Organization	MO	Springfield
59	St. Joseph Area Transportation Study Organization	MO	St. Joseph
60	Capital Area MPO	NC	Raleigh
61	Mecklenburg-Union MPO	NC	Charlotte
62	Nashua Regional Planning Commission	NH	Nashua

MPO IO Models Developed In 2001 (Continued)

#	MPO Name	State	City
63	Rockingham Planning Commission	NH	Exeter
64	Southern New Hampshire Planning Commission	NH	Manchester
65	Strafford Regional Planning Commission	NH	Dover
66	Las Cruces MPO	NM	Las Cruces
67	Mid-Region COG	NM	Albuquerque
68	Santa Fe MPO	NM	Santa Fe
69	Adirondack/Glens Falls Transportation Council	NY	Fort Edward
70	Binghamton Metropolitan Transportation Study	NY	Binghamton
71	Capital District Transportation Committee	NY	Albany
72	Elmira-Chemung Transportation Council	NY	Elmira
73	Genesee Transportation Council	NY	Rochester
74	Greater Buffalo-Niagara Regional Transportation Council	NY	Buffalo
75	Herkimer-Oneida Counties Transportation Study	NY	Utica
76	Ithaca-Tompkins County Transportation Council	NY	Ithaca
77	New York Metropolitan Transportation Council	NY	New York
78	Orange County Transportation Council	NY	Goshen
79	Poughkeepsie-Dutchess County Transportation Council	NY	Poughkeepsie
80	Syracuse Metropolitan Transportation Council	NY	Syracuse
81	Akron Metropolitan Area Transportation Study	OH	Akron
82	Brook-Hancock-Jefferson Metropolitan Planning Commission	OH	Steubenville
83	Cincinnati-Northern Kentucky MPO	OH	Cincinnati
84	Clark County-Springfield Transportation Study	OH	Springfield
85	Eastgate Regional COG	OH	Austintown
86	Licking County Area Transportation Study	OH	Newark
87	Lima-Allen County Regional Planning Commission	OH	Lima
88	Miami Valley Regional Planning Commission	OH	Dayton
89	Mid-Ohio Regional Planning Commission	OH	Columbus
90	Northeast Ohio Areawide Coordinating Agency	OH	Cleveland
91	Richland County Regional Planning Commission	OH	Mansfield
92	Stark County Area Transportation Study	OH	Canton
93	Toledo Metropolitan Area COG	OH	Toledo
94	Bristol MPO	TN	Bristol
95	Chattanooga Urban Area MPO	TN	Chattanooga

MPO IO Models Developed In 2001 (Continued)

#	MPO Name	State	City
96	Clarksville Urbanized Area MPO	TN	Clarksville
97	Jackson Urban Area MPO	TN	Jackson
98	Johnson City Metropolitan Transportation Planning Organization	TN	Johnson City
99	Kingsport MPO	TN	Kingsport
100	Knoxville Regional Transportation Planning Organization	TN	Knoxville
101	Memphis Urban Area MPO	TN	Memphis
102	Nashville Area MPO	TN	Nashville
103	Chittenden County MPO	VT	South Burlington

Appendix B: MPO IO Models Developed In 2002

#	MPO Name	State	City
104	Auburn - Opelika MPO	AL	Opelika
105	Birmingham MPO	AL	Birmingham
106	Calhoun Area Transportation Study	AL	Anniston
107	Decatur MPO	AL	Decatur
108	Gadsden-Etowah MPO	AL	Gadsden
109	Huntsville Area Transportation Study	AL	Huntsville
110	Mobile Area Transportation Study	AL	Mobile
111	Montgomery Area MPO	AL	Montgomery
112	Shoals Area MPO	AL	Muscle Shoals
113	South Wiregrass Area MPO	AL	Dothan
114	Tuscaloosa Area MPO	AL	Northport
115	Flagstaff MPO	AZ	Flagstaff
116	Maricopa Association of Governments	AZ	Phoenix
117	Pima Association of Governments	AZ	Tucson
118	Yuma MPO	AZ	Yuma
119	Capital Region COG	CT	Hartford
120	Central Connecticut Regional Planning Agency	CT	Bristol
121	Council of Governments of the Central Naugatuck Valley	CT	Waterbury
122	Greater Bridgeport / Valley MPO	CT	Bridgeport
123	Housatonic Valley Council of Elected Officials	CT	Brookfield
124	Midstate Regional Planning Agency	CT	Middletown
125	South Central Regional COG	CT	North Haven
126	South Western Region MPO	CT	Stamford
127	Southeastern Connecticut COG	CT	Norwich
128	Burlington-Graham MPO	NC	Burlington
129	Cabarrus-South Rowan Urban Area MPO	NC	Concord
130	Durham-Chapel Hill-Carrboro MPO	NC	Durham
131	Fayetteville Area MPO	NC	Fayetteville
132	French Broad River MPO	NC	Asheville
133	Gaston Urban Area MPO	NC	Gastonia
134	Goldsboro Urban Area MPO	NC	Goldsboro

MPO IO Models Developed In 2002 (Continued)

#	MPO Name	State	City
135	Greater Hickory MPO	NC	Hickory
136	Greensboro Urban Area MPO	NC	Greensboro
137	Greenville Urban Area MPO	NC	Greenville
138	High Point Urban Area MPO	NC	High Point
139	Rocky Mount Urban Area MPO	NC	Rocky Mount
140	Wilmington Urban Area MPO	NC	Wilmington
141	Winston-Salem Urban Area MPO	NC	Winston-Salem
142	Anderson Area Transportation Study	SC	Anderson
143	Charleston Area Transportation Study	SC	North Charleston
144	Columbia Area Transportation Study	SC	Columbia
145	Florence Area Transportation Study	SC	Florence
146	Grand-Strand Area Transportation Study	SC	Georgetown
147	Greenville-Pickens Area Transportation Study	SC	Greenville
148	Rock Hill-Fort Mill Area Transportation Study	SC	Rock Hill
149	Spartanburg Area Transportation Study	SC	Spartanburg
150	Sumter Urban Area Transportation Study	SC	Sumter
151	Rapid City Area MPO	SD	Rapid City
152	South Eastern COG	SD	Sioux Falls
153	Abilene MPO	TX	Abilene
154	Amarillo MPO	TX	Amarillo
155	Brownsville MPO	TX	Brownsville
156	Bryan-College Station MPO	TX	Bryan
157	Capital Area MPO	TX	Austin
158	Corpus Christi MPO	TX	Corpus Christi
159	El Paso MPO	TX	El Paso
160	Hidalgo County MPO	TX	McAllen
161	Houston-Galveston Area Council	TX	Houston
162	Jefferson-Orange-Hardin Regional Transportation Study	TX	Beaumont
163	Killeen-Temple Urban Transportation Study	TX	Belton
164	Laredo Urban Transportation Study	TX	Laredo
165	Longview MPO	TX	Longview
166	Lubbock MPO	TX	Lubbock
167	Midland-Odessa Transportation Organization	TX	Midland

MPO IO Models Developed In 2002 (Continued)

#	MPO Name	State	City
168	North Central Texas COG	TX	Arlington
169	San Angelo MPO	TX	San Angelo
170	San Antonio-Bexar County MPO	TX	San Antonio
171	Sherman-Denison MPO	TX	Sherman
172	Texarkana MPO	TX	Texarkana
173	Tyler Urban Transportation Study MPO	TX	Tyler
174	Victoria MPO	TX	Victoria
175	Wichita Falls MPO	TX	Wichita Falls
176	Cache MPO	UT	Logan
177	Mountainland Association of Governments	UT	Orem
178	Wasatch Front Regional Council	UT	Salt Lake City
179	BCKP Regional Intergovernmental Council	WV	South Charleston
180	Belmont-Ohio-Marshall Transportation Study	WV	Wheeling
181	KYOVA Interstate Planning Commission	WV	Huntington
182	Wood-Washington-Wirt Interstate Planning Commission	WV	Parkersburg
183	Casper Area MPO	WY	Casper
184	Cheyenne MPO	WY	Cheyenne

Appendix C: MPO IO Models Developed In 2003

#	MPO Name	State	City
185	Bi-State MPO	AR	Fort Smith
186	Metroplan	AR	Little Rock
187	Northwest Arkansas Regional Transportation Study	AR	Springdale
188	Southeast Arkansas Regional Planning Commission	AR	Pine Bluff
189	West Memphis Area Transportation Study	AR	West Memphis
190	National Capital Region Transportation Planning Board	DC	Washington
191	Dover / Kent County MPO	DE	Dover
192	Wilmington Area Planning Council	DE	Newark
193	Area Plan Commission of Tippecanoe County	IN	Lafayette
194	Bloomington Area Transportation Study	IN	Bloomington
195	Delaware-Muncie Metropolitan Plan Commission	IN	Muncie
196	Evansville MPO	IN	Evansville
197	Indianapolis MPO	IN	Indianapolis
198	Kokomo & Howard County Governmental Coordinating Council	IN	Kokomo
199	Madison County COG	IN	Anderson
200	Michiana Area COG	IN	South Bend
201	Northeastern Indiana Regional Coordinating Council	IN	Ft. Wayne
202	Northwest Indiana Regional Planning Commission	IN	Portage
203	West Central Indiana Economic Development District, Inc.	IN	Terre Haute
204	Lawrence-Douglas County Metropolitan Planning Office	KS	Lawrence
205	Topeka-Shawnee County Metropolitan Planning Commission	KS	Topeka
206	Wichita Area MPO	KS	Wichita
207	Southeastern Regional Planning & Economic Development District	MA	Taunton
208	Baltimore Regional Transportation Board	MD	Baltimore
209	Cumberland MPO	MD	Cumberland
210	Hagerstown-Eastern Panhandle MPO	MD	Hagerstown
211	Battle Creek Area Transportation Study	MI	Springfield
212	Bay City Area Transportation Study	MI	Bay City
213	Genesee County Metropolitan Planning Commission	MI	Flint
214	Grand Valley Metropolitan Council	MI	Grand Rapids
215	Kalamazoo Area Transportation Study	MI	Kalamazoo

MPO IO Models Developed In 2003 (Continued)

#	MPO Name	State	City
216	Macatawa Area Coordinating Council	MI	Holland
217	Region 2 Planning Commission	MI	Jackson
218	Saginaw Metropolitan Area Transportation Study	MI	Saginaw
219	Southwestern Michigan Commission	MI	Benton Harbor
220	Tri-County Regional Planning Commission	MI	Lansing
221	Western Michigan Shoreline Regional Development Commission	MI	Muskegon
222	Central Mississippi Planning & Development District	MS	Jackson
223	Gulf Regional Planning Commission	MS	Gulfport
224	Hattiesburg-Petal-Forrest-Lamar MPO	MS	Hattiesburg
225	Lincoln MPO	NE	Lincoln
226	Metropolitan Area Planning Agency	NE	Omaha
227	North Jersey Transportation Planning Authority	NJ	Newark
228	South Jersey Transportation Planning Organization	NJ	Vineland
229	Blair County Planning Commission	PA	Altoona
230	Cambria County MPO	PA	Ebensburg
231	Centre County MPO	PA	State College
232	Delaware Valley Regional Planning Commission	PA	Philadelphia
233	Erie MPO	PA	Erie
234	Harrisburg Area Transportation Study	PA	Harrisburg
235	Lackawanna-Luzerne Transportation Study	PA	Scranton
236	Lancaster County Transportation Coordinating Committee	PA	Lancaster
237	Lehigh Valley Transportation Study	PA	Allentown
238	Reading Area Transportation Study	PA	Reading
239	Shenango Valley Area Transportation Study	PA	Hermitage
240	Southwestern Pennsylvania Commission	PA	Pittsburgh
241	Williamsport Area Transportation Study	PA	Williamsport
242	York Area MPO	PA	York
243	State Planning Council	RI	Providence
244	Harlingen-San Benito MPO	TX	Harlingen
245	Central Virginia MPO	VA	Lynchburg
246	Charlottesville-Albemarle MPO	VA	Charlottesville
247	Danville MPO	VA	Martinsville
248	Fredericksburg Area MPO	VA	Fredericksburg

MPO IO Models Developed In 2003 (Continued)

#	MPO Name	State	City
249	Hampton Roads MPO	VA	Chesapeake
250	Richmond Area MPO	VA	Richmond
251	Roanoke Valley MPO	VA	Roanoke
252	Tri Cities Area MPO	VA	Petersburg
253	Tri-Cities Metropolitan Area Transportation Study	WA	Richland
254	Chippewa-Eau Claire MPO	WI	Eau Claire
255	East Central Wisconsin Regional Planning Commission	WI	Menasha
256	Green Bay MPO	WI	Green Bay
257	Janesville Area MPO	WI	Janesville
258	La Crosse Area Planning Committee	WI	La Crosse
259	Madison Area MPO	WI	Madison
260	Marathon County Metropolitan Planning Commission	WI	Wausau
261	Sheboygan MPO	WI	Green Bay
262	Southeastern Wisconsin Regional Planning Commission	WI	Waukesha
263	State Line Area Transportation Study	WI	Beloit

Appendix D: MPO IO Models Developed In 2004

#	MPO Name	State	City
264	Anchorage Metropolitan Area Transportation Solutions	AK	Anchorage
265	Association of Monterey Bay Area Governments	CA	Marina
266	Bay Area MPO	CA	Oakland
267	Butte County Association of Governments	CA	Chico
268	Council of Fresno County Goverrnments	CA	Fresno
269	Kern COG	CA	Bakersfield
270	Merced County Association of Governments	CA	Merced
271	Sacramento Area COG	CA	Sacramento
272	San Diego Association of Governments	CA	San Diego
273	San Joaquin COG	CA	Stockton
274	San Luis Obispo COG	CA	San Luis Obispo
275	Santa Barbara County Association of Governments	CA	Santa Barbara
276	Shasta County Regional Transportation Planning Agency	CA	Redding
277	Southern California Association of Governments	CA	Los Angeles
278	Stanislaus COG	CA	Modesto
279	Tulare County Association of Governments	CA	Visalia
280	Denver Regional COG	CO	Denver
281	Grand Junction / Mesa County MPO	CO	Grand Junction
282	North Front Range MPO	CO	Fort Collins
283	Pikes Peak Area COG	CO	Colorado Springs
284	Pueblo Area COG	CO	Pueblo
285	Atlanta Regional Commission	GA	Atlanta
286	Augusta Regional Transportation Study	GA	Augusta
287	Brunswick Area Transportation Study	GA	Brunswick
288	Chatham Urban Transportation Study	GA	Savannah
289	Columbus-Phenix City Transportation Study	GA	Columbus
290	Dougherty Area Regional Transportation Study	GA	Albany
291	Floyd-Rome Urban Transportation Study	GA	Rome
292	Macon Area Transportation Study	GA	Macon
293	Madison Athens-Clarke Oconee Regional Transportation Study	GA	Athens
294	Warner Robins Area Transportation Study	GA	Warner Robins

MPO IO Models Developed In 2004 (Continued)

#	MPO Name	State	City
295	Oahu MPO	HI	Honolulu
296	Lexington Area MPO	KY	Lexington
297	Louisville Area MPO	KY	Louisville
298	Owensboro-Daviess County MPO	KY	Owensboro
299	Alexandria MPO	LA	Alexandria
300	Capital Regional Planning Commission	LA	Baton Rouge
301	Houma-Thibodaux MPO	LA	Houma
302	Imperial Calcasieu Regional Planning & Development Commission	LA	Lake Charles
303	Lafayette Area MPO	LA	Lafayette
304	Northwest Louisiana COG	LA	Shreveport
305	Ouachata Council of Governments	LA	Monroe
306	Regional Planning Commission	LA	New Orleans
307	Androscoggin Transportation Resource Center	ME	Auburn
308	Bangor Area Comprehensive Transportation System	ME	Bangor
309	Kittery Area Comprehensive Transportation Study	ME	Springvale
310	Portland Area Comprehensive Transportation Committee	ME	Portland
311	Duluth-Superior Metropolitan Interstate Committee	MN	Duluth
312	Metropolitan Council	MN	St. Paul
313	Rochester-Olmsted COG	MN	Rochester
314	St. Cloud Area Planning Organization	MN	St. Cloud
315	Great Falls MPO	MT	Great Falls
316	Missoula Transportation Policy Coordinating Committee	MT	Missoula
317	Yellowstone County Planning Board	MT	Billings
318	Bismarck-Mandan MPO	ND	Bismark
319	Fargo-Morehead Metropolitan COG	ND	Fargo
320	Grand Forks-East Grand Forks MPO	ND	Grand Forks
321	Regional Transportation Commission of Southern Nevada	NV	Las Vegas
322	Regional Transportation Commission of Washoe County	NV	Reno
323	Tahoe MPO	NV	Stateline
324	Association of Central Oklahoma Governments	OK	Oklahoma City
325	Indian Nations COG	OK	Tulsa
326	Lawton MPO	OK	Lawton
327	Central Lane MPO	OR	Eugene

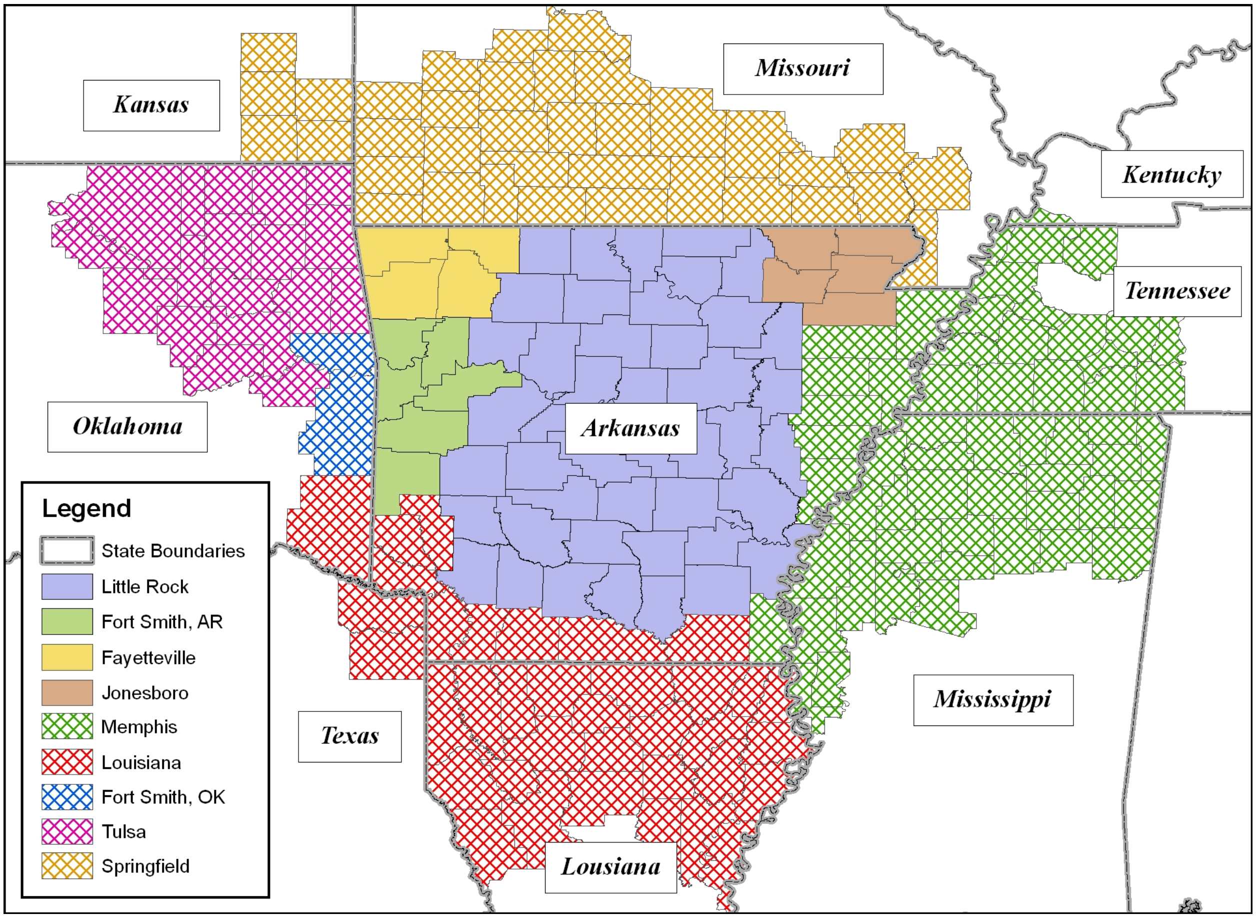
MPO IO Models Developed In 2004 (Continued)

#	MPO Name	State	City
328	Metro	OR	Portland
329	Rogue Valley COG	OR	Central Point
330	Salem-Keizer Area Transportation Study	OR	Salem
331	Longview-Kelso-Rainier MPO	WA	Kelso
332	Puget Sound Regional Council	WA	Seattle
333	Southwest Washington Regional Transportation Council	WA	Vancouver
334	Spokane Regional Transportation Council	WA	Spokane
335	Thurston Regional Planning Council	WA	Olympia
336	Whatcom COG	WA	Bellingham
337	Yakima Valley MPO	WA	Yakima

Appendix E: Phoenix MPO Distance Matrix

Region Name	Maricopa (AZ)	Albuquerque, AZ	AlbuquerqueAZ, NM	Flagstaff, AZ	FlagstaffAZ, UT	Las Vegas, AZ	las VegasAZ, NV	Los Angeles, AZ	Los AngelesAZ, CA	Phoenix2, AZ	PhoenixAZ, NM	Tuscon, AZ
Maricopa (AZ)	0.48	6.30	9.90	3.60	6.25	4.80	7.50	2.40	5.70	0.60	6.60	3.00
Albuquerque, AZ	6.30	0.40	3.00	2.25	5.50	5.25	7.25	7.00	11.70	5.40	7.25	7.50
AlbuquerqueAZ, NM	9.90	3.00	0.48	5.50	8.50	8.25	10.50	10.00	15.30	9.30	5.00	9.30
Flagstaff, AZ	3.60	2.25	5.50	0.40	3.25	3.00	5.00	4.75	9.00	2.70	7.25	5.10
FlagstaffAZ, UT	6.25	5.50	8.50	3.25	0.40	6.25	5.00	8.00	10.50	5.50	10.50	7.50
Las Vegas, AZ	4.80	5.25	8.25	3.00	6.25	0.40	2.70	3.00	5.40	4.50	8.75	6.90
las VegasAZ, NV	7.50	7.25	10.50	5.00	5.00	2.70	0.48	4.50	4.50	7.20	10.75	9.60
Los Angeles, AZ	2.40	7.00	10.00	4.75	8.00	3.00	4.50	0.40	3.60	3.30	8.70	5.70
Los AngelesAZ, CA	5.70	11.70	15.30	9.00	10.50	5.40	4.50	3.60	0.48	6.30	12.00	8.70
Phoenix2, AZ	0.60	5.40	9.30	2.70	5.50	4.50	7.20	3.30	6.30	0.48	5.70	2.40
PhoenixAZ, NM	6.60	7.25	5.00	7.25	10.50	8.75	10.75	8.70	12.00	5.70	0.40	2.75
Tuscon, AZ	3.00	7.50	9.30	5.10	7.50	6.90	9.60	5.70	8.70	2.40	2.75	0.48

Appendix F: Map of Arkansas Meta-Region



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