Documentation of Data Methods and Accounting Framework for the UMRIO-95 Regional I-O Modeling Project

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GOPB is rebuilding the regional input-output (I-O) component of its demographic and economic modeling system. The current revision has a baseyear of 1995, and will be called the Utah Multiregional Input-Output-1995 model, or UMRIO-95 for short. This paper documents data sources and assembly methods, and it details the accounting framework for the UMRIO-95 model. UMRIO-95 is the 4th generation in an I-O modeling effort launched by GOPB 10 years ago. The 2nd and 3rd generation models each reflected advances over predecessors, particularly in the area of region definition and interregional trade.[1]

The present UMRIO revision shifts emphasis to building compatibility with other facets of GOPB economic and demographic models, compatibility with the multicounty planning districts

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[1] The original "Miller-Robison" model appeared in 1988 (Miller and Robison, 1990). It had a 1982 base-year and divided the State into three unconnected regions. The first model named UMRIO had a 1989 base-year, divided Utah into 5 regions, and connected regions in one-way core-periphery trade (Robison, 1993) . That model was funded by the former Utah Division of Energy to look at Utah HB110. UMRIO-89 was combined with a parallel but otherwise unrelated effort in Idaho (the Idaho Economic Modeling Project, IDAEMP), and featured in a refereed journal article (Robison and others, 1994). UMRIO-92 was constructed with data assembled by GOPB. It divided the state into 9 regions and included an interregional form that captured two-way trade and limited commuting effects (Robison and Donner, 1994).

(MCDs) used in other GOPB analysis, and compatibility of data between UMRIO and UPED. We also streamline certain aspects of data development by relying on purchased IMPLAN (Minnesota IMPLAN Group, Stillwater, Minnesota) data rather than constructing the data *from scratch.*

UMRIO-95 models are conveyed in *Excel* spreadsheets. There are UMRIO-95 models for nine regions. One for each of GOPB's seven MCDs, one for GOPB's QGET region, and one Utah statewide model. In addition, we construct four models with alternative multiplier specifications for each of the nine regions. The four multiplier specifications are described and formally defined in a latter section of the paper.

This paper is broadly divided into two parts. Data assembly methods are considered in Part I, while Part II details UMRIO-95's accounting structure, multiplier specifications, and regionalizing approach. Readers interested in additional background and past UMRIO models are referred to Miller and Robison (1990); Robison (1993); and Robison and Donner (1994).

PART I: BUILDING THE JOBS AND INCOME BASE DATA

Jobs Data in UPED and UMRIO: Overview

Jobs and Incomes at the 2-Digit Level

UPED presents jobs data for 65 sectors: wage & salary jobs for 63 roughly SIC 2-digit non-farm sectors, and total jobs for farms and private households. The data include an estimate of aggregate non-farm proprietors' jobs as a 66th data element. UMRIO-95, and most other regional I-O models (IMPLAN included), convey total jobs only. The pivotal step in building data consistency between UPED and UMRIO-95 is building a set of proprietor job estimates into UMRIO-95. A mix of REIS confidential and public domain data provide raw material for arriving at proprietor job estimates, initially at the SIC 2-digit level. They also serve as a check on the quality of IMPLAN and other derived data.

Producing UMRIO-95 proprietor job estimates occasions a look at income-job ratios for proprietors. Proprietor income losses appear as negatives in REIS data. If carried into the I-O model, these negatives would produce perplexing results in impact analysis, in particular, incomes that go up with downturns, and down with upturns. We apply a procedure that eliminates negative incomes by setting a floor on proprietors' income per job equal to that of wage & salary jobs. An unavoidable result of this adjustment is that our aggregate earnings estimate will be higher than that reported by REIS.

Jobs and Incomes at the 4-Digit Level

IMPLAN provides data at the SIC 4-digit level on earnings, i.e., wage & salary income plus proprietors' income, and total jobs, i.e., wage & salary and proprietors' jobs. We construct provisional estimates of wage & salary jobs, and proprietors' jobs, and then control these to our REIS-controlled SIC 2-digit vectors of the same. We control IMPLAN earnings estimates to REIS 2-digit earnings estimates (with adjustments made to eliminate proprietors' losses).

Bridging UPED and REIS

Unfortunately, UPED 2-digit data on wage & salary jobs and non-farm proprietors do not agree with REIS for the same measures. Our approach is to build UMRIO 4-digit data controlled to REIS 2-digit data[2] and then control these estimates to UPED. The approach assures that UPED and UMRIO report the same jobs. A drawback is that UMRIO and REIS will not strictly

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[2] As detailed below, "REIS-controlled" earnings estimates exceed actual REIS reported earnings due to an adjustment to eliminate negative proprietors' incomes.

agree.

Controlling I-O Model Data to REIS

The REIS controlled 4-digit data set entails two fundamental steps: the first focuses on REIS data alone, and results in a adjusted 2-digit data set with proprietor jobs and earnings free of proprietor losses. The second step introduces IMPLAN data, and results in a 4-digit data set that includes estimates of wage & salary jobs and proprietor jobs both controlled to UPED, and earnings estimates generally consistent with REIS, but adjusted to eliminate outliers including negative proprietors' incomes.

Step 1: Jobs and Earnings at the Sic 2-digit Level.

Estimate Proprietor jobs at the SIC 1-digit Level.

We start by estimating proprietors' jobs at the SIC 1-digit level. The procedure is accomplished by subtracting REIS report CA27 from CA25. The procedure can be represented symbolically as follows:

(1) $$\underbrace{({}_{C}W_{J}^{1} + {}_{C}P_{J}^{1})}_{\text{CA25}} - \underbrace{{}_{C}W_{J}^{1}}_{\text{CA27}} = {}_{C}\overline{P}_{J}^{1}$$

where:

${}_{C}\overline{P}_{J}^{1} =$ proprietors' jobs for county (or multicounty) areas, at the SIC 1-digit level.

${}_{C}W_{J}^{1} =$ wage & salary jobs for county (or multicounty) areas, at the SIC 1-digit level.

We note that the farm element in our estimate of proprietors' jobs agrees with the aggregate "farm proprietors' employment" shown in both CA25 and CA27. Also, the sum of other elements agrees with the aggregate report of "nonfarm proprietors' employment."

Estimate Proprietor Jobs at the SIC 2-digit Level.

We start by making a provisional estimate of proprietor jobs at the county (multicounty) and SIC 2-digit level assuming the ratio of proprietor to wage & salary jobs reported in the REIS public domain state-level reports SA25 and SA27. We first estimate proprietors' jobs at the state level.[3]

(2)

$$\underbrace{({}_S W_J^2 + {}_S P_J^2)}_{\text{SA25}} - \underbrace{{}_S W_J^2}_{\text{SA27}} = {}_S \overline{P}_J^2$$

Our provisional estimate of proprietors' jobs at the county-level is given by[4]:

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[3] REIS SA data are public domain and there were 4 incidents of suppression in SA27. These cases referred to small sectors, e.g., "forestry," and "fisheries," and in every case a subtotal value was available in the larger report. We filled in for suppressed values assuming the distribution of subtotal amounts according to the distribution indicated in the sum of the confidential CA27 reports.

[4] If there are proprietors' jobs at the 1-digit level but no wage & salary jobs at the 2-digit level then expression (3) will show zero provisional proprietors' jobs at the 2-digit level, which causes a problem in expression (4) where 2-digit proprietors' jobs are controlled to 1-digit proprietors' jobs. Of 2-digit industries and 29 Utah counties, 2,262 data elements, we find 4 incidents of this problem. In these 4 cases, we distribute proprietors' jobs according to the distribution of earnings shown in the appropriate REIS CA05 report.

$$(3) \quad {}_{C}\tilde{P}_{J}^{2} = {}_{C}W_{J}^{2} \cdot \frac{{}_{S}\bar{P}_{J}^{2}}{{}_{S}W_{J}^{2}}$$

where

${}_{C}W_{J}^{2} =$ is 2-digit wage & salary jobs as reported in CA27.

Our final estimate of proprietors' jobs at the county-level is obtained by controlling our provisional estimates to the 1-digit estimates obtained in equation (1):

$$(4) \quad {}_{C}\bar{P}_{J}^{2} = {}_{C}\tilde{P}_{J}^{2} \mid {}_{C}P_{J}^{1}$$

Set floor on Proprietors' Income

We obtain a SIC 2-digit estimate of proprietors' income by subtracting REIS report CA07 from report CA05. The procedure results in occasional negative entries, reflecting proprietor losses in the data year. Negative values produce perplexing results in I-O models used for impact analysis, e.g., incomes that go down in expansions and up in contractions.

The problem is more general than negative incomes. In any given year, proprietors' incomes might range high as well as low around some more representative norm. One approach would be to attempt to estimate the long term norm by examining many years of REIS data. Funding for the current UMRIO revision precludes this type of expensive time-series analysis.

In its place we adopt an alternative approach that is nonetheless grounded in some theory. In particular, we imagine that in the longer run proprietors will insist on making at least as much as wage & salary earners in the same industry or they will exit the industry. Applying this logic to our adjustments, we compute income per job for proprietors, and wage & salary workers, and set a floor on proprietors' income per job equal to wage & salary income per job.

The formal presentation of the adjustments starts with the formation of 2-digit income-job ratios for wage & salary workers and proprietors.

(5) $${}_{C}Y_{W}^{2} = \frac{{}_{C}W_{Y}^{2}}{{}_{C}W_{J}^{2}}$$

(6) $${}_{C}\overline{Y}_{P}^{2} = \frac{{}_{C}P_{Y}^{2}}{{}_{C}\overline{P}_{J}^{2}}$$

A revised set of ratios for proprietors' income are obtain through the following process:

(7) $${}_{C}\overline{Y}_{P}^{2} = {}_{C}Y_{W}^{2} \Leftrightarrow {}_{C}Y_{P}^{2} < {}_{C}Y_{W}^{2}$$

We use the revised vector of proprietors' income per job to obtained a revised estimate of proprietors' income thus:

(8) $${}_{C}\overline{P}_{Y}^{2} = {}_{C}P_{J}^{2} * {}_{C}\overline{Y}_{P}^{2}$$

Inasmuch as our process allows only upward adjustments in proprietors' income, our new estimate of county-wide earnings will be greater than the same as reported in the REIS CA05 reports. Symbolically:

$$\text{(9)} \quad {}_{C}\overline{P}_{Y}^{2} \geq {}_{C}P_{Y}^{2}$$

Our revised estimate of SIC 2-digit earnings reflects our revisions in proprietors' income to eliminate losses, and to bring parity with wage and salary employment. Our revised estimate of earnings is given by the following.

$$\text{(10)} \quad {}_{C}\overline{E}^{2} = {}_{C}\overline{P}_{Y}^{2} + {}_{C}\overline{W}_{Y}^{2}$$

Step 2: Estimate UPED Compatible Proprietor Jobs and Wage and Salary Jobs at the Sic 4-digit Level.

In this section we introduce IMPLAN data and move from the SIC 2-digit to the SIC 4-digit level. Our aim is to obtain the following 3 vectors for use in building our UMRIO-95 multicounty district models.[5]

${}_{C}\overline{P}_{J}^{4}$ 4-digit proprietors' jobs estimates for counties (or multicounty areas).

${}_{C}\overline{W}_{J}^{4}$ 4-digit wage & salary jobs estimates for counties (or multicounty areas).

[5] For notational convenience we refer to model areas generically as "multicounty areas," "multicounty districts," and "MCDs." It should be understood, howver, that these represent our seven MCDs, the QGET region, and the statewide model.

${}_{C}\overline{E}^{4}$ 4-digit earnings estimates for counties (or multicounty areas).

Estimating Wage & Salary and Proprietors' Jobs at the 4-digit Level

IMPLAN includes 4-digit estimates of total jobs (wage & salary jobs plus proprietors' jobs). We obtain a provisional estimate of wage & salary jobs by assuming the ratio of wage & salary jobs to total jobs observed in our 2-digit data developed earlier:

(11) $${}_{C}\tilde{W}_{J}^{4} = {}_{C}T_{J}^{4}\left(\frac{{}_{C}W_{J}^{2}}{{}_{C}\overline{T}_{J}^{2}}\right)$$

where:

$${}_{C}\overline{T}_{J}^{2} = {}_{C}W_{J}^{2} + {}_{C}\overline{P}_{J}^{2}$$

and

$${}_{C}T_{J}^{4} = {}_{C}W_{J}^{4} + {}_{C}P_{J}^{4}$$

Similarly, we obtain a provisional estimate of proprietors' jobs by assuming the ratio of proprietors' jobs to total jobs observed in our 2-digit data.

$$(12) \quad {}_{C}\tilde{P}_{J}^{4} = {}_{C}T_{J}^{4} \left(\frac{{}_{C}\overline{P}_{J}^{2}}{{}_{C}\overline{T}_{J}^{2}} \right)$$

We finalize our wage & salary jobs estimates by controlling our 4-digit provisional estimates to our 2-digit REIS-controlled estimates.

$$(13) \quad {}_{C}\overline{W}_{J}^{4} = {}_{C}\tilde{W}_{J}^{4} \; \Big| \; {}_{C}W_{J}^{2}$$

Similarly, we finalize our proprietors' jobs estimates by controlling these our earlier REIS-controlled estimates.

$$(14) \quad {}_{C}\overline{P}_{J}^{4} = {}_{C}\tilde{P}_{J}^{4} \; \Big| \; {}_{C}\overline{P}_{J}^{2}$$

Obtaining 4-digit Earnings Estimates

IMPLAN includes 4-digit estimates of earnings (wages and salary income plus proprietors' income). To obtain earnings estimates for use in UMRIO-95, we simply control IMPLAN's 4-digit earnings estimates our adjusted 2-digit earnings estimates (from equation 10).

$$(15) \quad {}_{C}\overline{E}^{4} = {}_{C}E^{4} \; \Big| \; {}_{C}\overline{E}^{2}$$

where:

$_{C}E^{4}$ 4-digit earnings estimates from IMPLAN (for multicounty areas).

Controlling 4-digit Jobs and Earnings to UPED

Thus far our data sets control to REIS data, i.e., the total of 4-digit wage, salary, and proprietor jobs control to 2-digit REIS total jobs, and 4-digit earnings control to 2-digit REIS except for our adjustments to put a floor on proprietors' income per job equal to wages per job. In this step we make adjustments to control 4-digit wage and salary data to 2-digit UPED, and the total of 4-digit proprietor jobs to control to proprietor job total shown in UPED. Earnings are adjusted in such a way that the ratio of earnings to jobs before the adjustments to control to UPED in this step are maintained after this step.

The specific steps needed to make these several adjustment are easy. First, in each county we compute the ratio of 4-digit earnings to total jobs based on our REIS-controlled data. Next we control our 4-digit wage and salary job estimates (for each county) to 2-digit UPED estimates, and we control 4-digit proprietor job estimates to the total of the same show in UPED. Wage and salary jobs are added to proprietors' jobs to equal total jobs, and these are multiplied by the earnings to total job ratio computed at the beginning of this step. The result is a revised set of 4-digit earnings estimates.

Final Adjustments to Eliminate Outlier Earnings per Job

In REIS data, earnings per worker can vary greatly from year to year because proprietors' income per job can vary greatly: Proprietors are generally small-scale independent capitalists, and their incomes can vary from significant losses (negative income) to near win-falls.

The typical GOPB use for UMRIO-95 is to simulate the impact of economic developments some date in the future. It would be unrealistic to assume outlier proprietor incomes per job in particular sectors will prevail into future projection years. Where proprietors earn losses, traditional theory of the firm would suggest out-migration, and the opposite where proprietors enjoy significantly above average returns. As described previously, we control proprietors' income per job in sectors to a floor equal to wage and salary incomes per job in those same sectors. This takes care of outlier proprietors' incomes on the low side. Our final adjustment takes care of cases where proprietors' income per job are unusually above wage and salary income per job.

Our procedure is simple. If proprietors' income per job in a given sector are greater than $35,000, then they are controlled to a ceiling of no more than twice wages and salary income per job. In other words, proprietors' income per job can be more than twice wages and salary income per job, provided it is no greater than $35,000. This latter exception is mainly observed in the agricultural sectors.

PART II: ACCOUNTING STRUCTURE, COEFFICIENT SOURCES, AND REGIONALIZING PROCEDURES

Underlying I-O Accounts

UMRIO-95 appears with four multiplier configurations, each differing in their degree of model closure. The first reflects the greatest closure: with respect to interindustry sales, households, a portion of local investment, and state and local government. We refer to this model as the Economic Base/Input-Output (EB/I-O) model (see Robison, 1997, for a discussion of the

EB/I-O model). A second model opens the EB/I-O model with respect to state and local government, i.e., the model is closed with respect to interindustry sales, households, and a portion of local investment. We refer to this model as the type III model.[6]

A third configuration opens the model one sector further: This model is closed with respect to interindustry sales and households. This model configuration provides a standard type II model. Finally, we provide a model closed with respect to interindustry sales only, i.e., a traditional type I model.

Underlying all four model configurations is the set of regional input-output accounts shown in matrix (16).

$$\begin{Bmatrix} [\boldsymbol{X}] \\ X_c \\ X_r \\ X_i \\ X_f \end{Bmatrix} = \begin{Bmatrix} \{\ \boldsymbol{x}\ \} & [\boldsymbol{C}] & [\boldsymbol{R}] & [\boldsymbol{I}] & [\boldsymbol{F}] & [\boldsymbol{E}] \\ (\boldsymbol{V_{cx}}) & 0 & V_{cr} & 0 & V_{cf} & V_c^* \\ (\boldsymbol{V_{rx}}) & 0 & V_{rr} & 0 & V_{rf} & V_r^* + Y_r \\ (\boldsymbol{V_{ix}}) & 0 & V_{ir} & 0 & V_{if} & V_i^* + Y_i \\ (\boldsymbol{0}) & 0 & 0 & 0 & 0 & Y_f \end{Bmatrix} \begin{Bmatrix} [\boldsymbol{1}] \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \end{Bmatrix} \tag{16}$$

Multidimensional arrays in (1) appear bold, and double subscripts denote a to-from relationship. Subscript ‘c’ refers to consumption, ‘r’ to state and local government, ‘i’ to

[6] We are taking some liberty with terminolgy here. By “type III” multipliers, most analysist invision multipleirs configured with marginal less than average propensities to spend (see Miller and Blair, 1985, p 110).

investment, ‘f’ to federal government, and ‘x’ to the industrial sectors.

For the sake of notational compactness, we aggregate state and local government into one sector, and federal government into another single sector. In the actual UMRIO-95 models, there are two state government sectors, “state public administration,” and “state schools.” Similarly, there two local government sectors, “local public administration,” and “local schools.” The federal government is divided into two sectors, “federal public administration,” and “military.” These divisions correspond to UPED.

Terms in matrix (1) that involve V are based on income generated in the region, while terms that involve V^* are based on residents’ outside income. Specific definitions are as follows:

$\{\boldsymbol{x}\}$ = matrix of interindustry trade.

$[\boldsymbol{X}]$ = vector of industry total gross outputs.

X_c = residents’ gross consumption spending.

X_r = state and local government gross expenditures (=revenues).

X_i = gross spending on local investment.

X_f = expenditures (=revenues) of federal government.

$(\boldsymbol{V_{cx}})$ = vector showing the portion of industry value added captured by residents and devoted to consumer goods spending.

$(\boldsymbol{V_{rx}})$ = vector showing the portion of industry value added captured by state and local government.

$(\boldsymbol{V_{ix}})$ = vector showing the portion of industry value added devoted to regional investment spending.

$[\boldsymbol{C}]$ = vector of business consumer goods sales to region residents.

$[\boldsymbol{R}]$ = vector of business sales to state and local government.

V_{cr} = residents' consumer goods purchases from income generated in state and local government.

V_{rr} = payments to state and local government from income generated in state and local government.

V_{ir} = regional investment spending from income generated in state and local government.

$[\boldsymbol{I}]$ = vector of business investment goods sales to region businesses and residents.

$[\boldsymbol{F}]$ = industry sales to federal government located in the region.

$[\boldsymbol{E}]$ = vector of business goods sales to nonresidents (i.e., regional exports)..

V_{cf} = consumer goods purchases from income generated in federal government located in the region.

V_{rf} = payments to state and local government from income generated in federal government located in the region.

V_{if} = local investment from income generated in federal government located in the region.

V_c^* = consumer goods purchases from residents' outside income.

V_r^* = payments to state and local government from residents' outside income.

V_i^* = local investment from residents' outside income.

Y_r = exogenous revenues of state and local government.

Y_i = exogenous investment.

$Y_f = X_f$ = outside revenues = gross revenues of federal government.

Multipliers in the Economic Base/I-O Model

Readers interested in the advocacy and use of I-O models closed in this fashion might consult Billings, 1969; Hirsch, 1973, p. 206; and Robison, 1997. Standard works on endogeniety in EB models include Andrews, 1953; Tiebout, 1962; and Isard, 1960. Matrix (17) presents the multipliers conveyed in our UMRIO-95 EB/I-O model.

$$\text{(17)} \qquad \begin{Bmatrix} [\boldsymbol{X}] \\ X_c \\ X_r \\ X_i \\ X_f \end{Bmatrix} = \begin{Bmatrix} \{\boldsymbol{I} - \boldsymbol{A}\} & [-\boldsymbol{a_c}] & [-\boldsymbol{a_r}] & [-\boldsymbol{a_i}] & [-\boldsymbol{a_f}] \\ (-\boldsymbol{a_{cx}}) & 1 & -\alpha_{cr} & 0 & -\alpha_{cf} \\ (-\boldsymbol{a_{rx}}) & 0 & 1-\alpha_{rr} & 0 & -\alpha_{rf} \\ (-\boldsymbol{a_{ix}}) & 0 & -\alpha_{ir} & 1 & -\alpha_{if} \\ (\boldsymbol{0}) & 0 & 0 & 0 & 1 \end{Bmatrix}^{-1} \begin{Bmatrix} [\boldsymbol{E}] \\ V_c^* \\ V_r^* + Y_r \\ V_i^* + Y_i \\ X_f \end{Bmatrix}$$

where, in addition to terms previously defined:

$(\boldsymbol{a_{rx}}) = (\boldsymbol{V_{rx}})\{\hat{\boldsymbol{X}}\}^{-1}$ = revenue-capture coefficients for the state and local government account.

$(\boldsymbol{a_{ix}}) = (\boldsymbol{V_{ix}})\{\hat{\boldsymbol{X}}\}^{-1}$ = appropriation coefficients for the local investment account.

$[\boldsymbol{a_r}] = [\boldsymbol{x}]\frac{1}{X_r}$ = state and local government spending coefficients.

$[\boldsymbol{a_i}] = [\boldsymbol{I}]\frac{1}{X_i}$ = local investment spending coefficients.

$[\boldsymbol{a_f}] = [\boldsymbol{F}]\frac{1}{X_f}$ = federal government spending coefficients.

$\alpha_{cr} = \frac{v_{cr}}{X_r}$ = coefficient of consumption spending from the income of state and local government employees.

$\alpha_{cf} = \frac{v_{cf}}{X_f}$ = coefficient of consumption spending from the income of federal government employees.

$\alpha_{rr} = \frac{v_{rr}}{X_r}$ = coefficient of state and local government revenue from the income of state and local government employees.

$\alpha_{rf} = \frac{v_{rf}}{X_f}$ = coefficient of state and local government revenue from the income of federal government employees.

$\alpha_{ir} = \frac{v_{ir}}{X_r}$ = coefficient of local investment from the income of state and local government employees.

$\alpha_{if} = \frac{v_{if}}{X_f}$ = coefficient of local investment from the income of federal government employees.

Multipliers in the Type III Model

Our type III models open the EB/I-O model with respect to state and local government. Accordingly, the type III model is closed with respect to interindustry sales, households, and a portion of local investment. Matrix (18) presents the multipliers conveyed in our Type III model.

(18)
$$\begin{Bmatrix} [\boldsymbol{X}] \\ X_c \\ X_r \\ X_i \\ X_f \end{Bmatrix} = \begin{Bmatrix} \{\boldsymbol{I} - \boldsymbol{A}\} & [-\boldsymbol{a_c}] & [-\boldsymbol{a_r}] & [-\boldsymbol{a_i}] & [-\boldsymbol{a_f}] \\ (-\boldsymbol{a_{cx}}) & 1 & -\alpha_{cr} & 0 & -\alpha_{cf} \\ (\ \boldsymbol{0}\ ) & 0 & 1 & 0 & 0 \\ (-\boldsymbol{a_{ix}}) & 0 & -\alpha_{ir} & 1 & -\alpha_{if} \\ (\ \boldsymbol{0}\ ) & 0 & 0 & 0 & 1 \end{Bmatrix}^{-1} \begin{Bmatrix} [\boldsymbol{E}] \\ V_c^* \\ X_r \\ V_i^* + Y_i \\ X_f \end{Bmatrix}$$

Multipliers in the Type II Model

The Type II model is closed in the traditional fashion (e.g., Miller and Blair, 1985) with respect to interindustry sales, and households. Matrix (19) presents the multipliers conveyed in our Type II model.

(19)

$$\begin{Bmatrix} [\boldsymbol{X}] \\ X_c \\ X_r \\ X_i \\ X_f \end{Bmatrix} = \begin{Bmatrix} \{\boldsymbol{I} - \boldsymbol{A}\} & [-\boldsymbol{a}_{\boldsymbol{c}}] & [-\boldsymbol{a}_{\boldsymbol{r}}] & [-\boldsymbol{a}_{\boldsymbol{i}}] & [-\boldsymbol{a}_{\boldsymbol{f}}] \\ (-\boldsymbol{a}_{\boldsymbol{cx}}) & 1 & -\alpha_{cr} & 0 & -\alpha_{cf} \\ (\ \mathbf{0}\ ) & 0 & 1 & 0 & 0 \\ (\ \mathbf{0}\ ) & 0 & 0 & 1 & 0 \\ (\ \mathbf{0}\ ) & 0 & 0 & 0 & 1 \end{Bmatrix}^{-1} \begin{Bmatrix} [\boldsymbol{E}] \\ V_c^{*} \\ X_r \\ X_i \\ X_f \end{Bmatrix}$$

Multipliers in the Type I Model

The Type I model is closed in the traditional fashion (e.g., Miller and Blair, 1985) with respect to interindustry sales only. Matrix (20) presents the multipliers conveyed in our Type I model.

(20)

$$\begin{Bmatrix} [\boldsymbol{X}] \\ X_c \\ X_r \\ X_i \\ X_f \end{Bmatrix} = \begin{Bmatrix} \{\boldsymbol{I} - \boldsymbol{A}\} & [-\boldsymbol{a}_{\boldsymbol{c}}] & [-\boldsymbol{a}_{\boldsymbol{r}}] & [-\boldsymbol{a}_{\boldsymbol{i}}] & [-\boldsymbol{a}_{\boldsymbol{f}}] \\ (\ \mathbf{0}\ ) & 1 & 0 & 0 & 0 \\ (\ \mathbf{0}\ ) & 0 & 1 & 0 & 0 \\ (\ \mathbf{0}\ ) & 0 & 0 & 1 & 0 \\ (\ \mathbf{0}\ ) & 0 & 0 & 0 & 1 \end{Bmatrix}^{-1} \begin{Bmatrix} [\boldsymbol{E}] \\ X_c \\ X_r \\ X_i \\ X_f \end{Bmatrix}$$

National Model Coefficient Sources

In a break with past UMRIO models, UMRIO-95 is based on national coefficients extracted from the 1995 national IMPLAN model. Utilizing the IMPLAN-Pro Software package, we constructed a 1985 U.S. National I-O model, and extracted the traditional industry-by-industry direct coefficients matrix. We augmented this matrix with value added coefficients, and this provides the interindustry portion of our I-O accounts as shown in matrix (16).

We obtained column coefficients for government, investment, and personal consumption sectors by turning to IMPLAN-Pro's Reports Option, and extracting a "Final Demand" report for the "industry based" accounts. We add together final demand consumption vectors for high, low, and medium household incomes to form a single personal consumption vector. We then normalize this vector to provide our vector of personal consumption coefficients.

We have four government vectors to estimate, federal non-defense, federal defense, state and local non-education, and state and local education. Our state and local government vectors perform double duty, serving to model both local, e.g., local public administration, and state e.g., state public administration sectors. Our general approach is to extract the government from IMPLAN-Pro's "Final Demand Report," and then append to the bottom of these an estimate of government value added. The appended columns are then normalized to provide our government sector final demand coefficients.

Investment coefficients are obtained by simply normalizing the "capital vector" from IMPLAN-Pro's "Final Demand Report."

Regionalizing the Models

We build UMRIO-95 based on national I-O model coefficients obtained from IMPLAN. These are transformed to regional coefficients using a mixed location-quotient/supply-demand-pool regionalizing approach. Schaffer and Chu (1969) provide the classic discussion of the location-quotient and supply-demand-pool regionalizing approaches.

Location-quotient and supply-demand-pool regionalizing procedures have a recognized tendency to understate exports. Accordingly, we compute both location-quotient and supply-demand-pool estimates of regional exports, and select the larger of the two for our UMRIO-95 models. It should be noted that this strictly mechanical approach to estimating regional exports represents break with past UMRIO exercises that relied in part on “expert judgement (see for example, Robison and Donner, 1994).”

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